THE CHAROPHYTA OF MALAYSIA AND ADJACENT COUNTRIES

PROEFSCHRIFT

TER VERKRIJGING VAN DEN GRAAD VAN DOCTOR IN DE WIS- EN NATUURKUNDE AAN DE RIJKSUNIVERSITEIT TE LEIDEN, OP GEZAG VAN DEN RECTOR MAGNIFICUS DR A. W. BYVANCK, HOOGLEERAAR IN DE FACULTEIT DER LETTEREN EN WIJSBEGEERTE, VOOR DE FACULTEIT DER WIS- EN NATUURKUNDE TE VERDEDIGEN OP WOENSDAG 21 MEI 1941, DES NAMIDDAGS TE DRIE UUR

DOOR

JACQUES SIMON ZANEVELD,

GEBOREN TE SCHEVENINGEN

LEIDEN
N.V. BOEK- EN STEENDRUKKERIJ EDUARD IJDO
MCMXLI

AAN MIJN MOEDER
AAN MIJN VROUW

VOORWOORD.

Bij het overzien van mijn tans afgesloten academische studietijd en de daaraan voorafgegane periode, is het mij een behoefte enkele van de meest belangrijke feiten hier vast te leggen en een woord van dank en erkentelijkheid uit te spreken aan allen, die op enigerlei wijze tot mijn vorming hebben bijgedragen.

Dit proefschrift zij in de eerste plaats opgedragen aan mijn MOEDER, *die het mij mogelijk maakte een universitaire opleiding te volgen, waarvoor ik haar mijn warme dank betuig.*

Mede zij dit proefschrift opgedragen aan mijn VROUW, *om haar te danken voor de wijze, waarop ze zo vaak haar persoonlijke verlangens op zij wist te zetten om het doel, dat wij beiden voor ogen hadden, te bereiken.*

U, Hoogleraren en verdere Docenten in de Faculteit van de Wis- en Natuurkunde, dank ik voor alles, wat ik in de afgelopen jaren op colleges, practica, excursies en tentamens heb mogen leren.

In het bizonder geldt deze dank U, Hoogleraren en Docenten in de Biologie. Vooral denk ik daarbij met grote erkentelijkheid aan de niet genoeg te waarderen wijze, waarop Gij de studenten gelegenheid geeft tot zelfwerkzaamheid en hun grote zelfstandigheid laat bij het kiezen van een hun „liggende" richting.

Hooggeleerde BAAS BECKING, *meer speciaal zijt Gij het geweest, die mij het door de klassikale opvoeding geschokte zelfvertrouwen hebt doen terugvinden en mij aanzette na het beëindigen van de studie voor de Middelbare Akte de academische examens af te leggen. Mijn erkentelijkheid hiervoor is veel groter dan ik vermag onder woorden te brengen. Zeer dankbaar ben ik U ook voor al het vele, dat ik onder Uw bezielende leiding mocht leren, vooral op het gebied van de veldbiologie.*

Zeergeleerde VERWEY, *een groot aandeel van mijn vorming ben ik U verschuldigd en ik ben blij, eindelijk een gelegenheid te hebben U voor de prettige wijze, waarop Gij mij leiding wist te geven, openlijk mijn welgemeende en diepgevoelde dank te betuigen. Mijn belangstelling in de mariene biologie, het eerst opgewekt door U, Zeergeleerde* STIASNY,

waarvoor ik U gaarne mijn dank betuig, werd aan het Zoölogische Station onder Uw critische en enthousiaste leiding in de juiste banen geleid. Voor de gastvrijheid tijdens de verschillende perioden van mijn verblijf in Den Helder ondervonden, ben ik ook U, Mevrouw VERWEY, *zeer dankbaar.*

Hooggeleerde LAM, *Hooggeachte Promotor, eerst langzamerhand ben ik gaan begrijpen, dat onze opvattingen grotendeels parallel liepen. Ik acht het dan ook een groot voorrecht als assistent onder Uw energieke leiding aan het Rijksherbarium dit proefschrift te hebben kunnen samenstellen. Voor Uw voortdurende belangstelling, voor de hulp, die U mij bij het uitwerken van de verschillende problemen verleende en voor de wijze, waarop Gij steeds onmiddellijk bereid waart Uw mening over bepaalde punten te zeggen, ben ik U zeer dankbaar.*

Zeergeleerde DE GAAY FORTMAN, *de wijze, waarop Gij in de eerste jaren van de middelbare school mijn belangstelling voor de biologie wist te wekken en mij later in de gelegenheid stelde onderwijservaring op te doen, zal bij mij in dankbare herinnering blijven.*

Geleerde DE BOER, *U ben ik zeer dankbaar voor Uw interessante lessen in de biologie en voor de aanmoediging en hulp, die ik van U mocht ontvangen gedurende de laatste twee jaren van mijn H. B. S.-tijd.*

De bereidwilligheid, waarmee Gij, Geleerde TYMSTRA, *mij in de gelegenheid hebt gesteld een verzuim ongedaan te maken, zal ik altijd op zeer hoge prijs blijven stellen. Ook de leraren van Uw school ben ik voor hun tegemoetkomende houding zeer erkentelijk.*

Een bizonder woord van dank wil ik tot U richten, Geleerde BIRNIE, *voor de leerzame en prettige tijd, gedurende welke ik onder Uw leiding als docent aan het Rijnlands Lyceum verbonden ben geweest. Dat ik het lyceum vaarwel zei, doet geenszins afbreuk aan de waarde, die de kennismaking met het Dalton-onderwijs voor mij gehad heeft.*

Zeergeleerde NICOLAI, *Zeergeleerde* KARSTENS, *ook U beiden wil ik hier danken voor de mij bij verschillende gelegenheden geboden hulp.*

Voorts zeg ik allen, die mij op enigerlei wijze bij het tot stand komen van dit proefschrift behulpzaam zijn geweest, hartelijk dank, in het bizonder mijn collega's, leden van de Staf van het Rijksherbarium.

Tenslotte wens ik het technische personeel van het Rijksherbarium te bedanken voor hun grote hulpvaardigheid. Vooral dank ik de bibliothecaris, de Heer H. J. VAN DER HEE, *voor zijn hulp bij het opsporen en aanvragen van de vele literatuur, terwijl ik de Heer* C. MULDER, *tekenaar, zeer erkentelijk ben voor de uitstekende verzorging van de tekeningen.*

Leiden, November 1940.

SAMENVATTING

De enige systematische bewerking van de *Charophyta* van Nederlands-Indië dateert van 1849 [1]) en is samengesteld door ALEX. BRAUN. Weliswaar gaf DE WILDEMAN in 1897, aangevuld in 1899, een opsomming van alle, tot die tijd gepubliceerde soorten en in 1900 een beschrijving van de Javaanse *Charophyta,* terwijl FILARSZKY (1934) de soorten beschreef, die in 1928 en 1929 door de Duitse Limnologische Soenda-Expeditie verzameld werden, maar een recente uitgebreide bewerking van de *Charophyta* van Nederlands-Indië ontbrak. Deze wordt in dit proefschrift gegeven, waarin bovendien de soorten zijn opgenomen, die in Malakka, Brits Noord-Borneo, de Philippijnen, Portugees Timor en Australisch Nieuw-Guinee verzameld werden. Het genoemde gebied wordt in navolging van LAM (1937) en VAN STEENIS (1937) aangeduid met de biogeografische term Malesië („Malaysia''). Uit plantengeografisch oogpunt was het echter wenselijk tevens de soorten te bespreken, die in Brits-Indië (incl. Ceylon), Siam en Indo-China gevonden zijn. Door het uitbreken van de oorlog was het helaas onmogelijk van al deze soorten het type-exemplaar te zien te krijgen, reden waarom bedoelde soorten met een kleine letter zijn gedrukt en in de determinatietabellen cursief zijn aangegeven. Tevens springen daardoor de soorten, die in Malesië voorkomen, dadelijk in het oog. Het bestudeerde materiaal, hoofdzakelijk droog geconserveerd, was afkomstig uit de herbaria, die op p. 3 zijn opgesomd.

Het vorenstaande wordt in de Inleiding van dit proefschrift nader toegelicht, dat voor het overige uit twee delen bestaat, n.l. een algemeen en een systematisch deel.

In het Systematische Deel worden 61 soorten beschreven, waarvan er 30 behoren tot het geslacht *Nitella,* 3 tot *Tolypella,* 2 tot *Nitellopsis,* 1 tot *Lychnothamnus* en 25 tot *Chara.* Hierbij zijn de beschrijvingen van 5 nieuwe soorten, waarvan er 3 behoren tot het geslacht *Nitella,* n.l. *N. moniliformis, N. tumulosa* en *N. Alleninda,* 1 tot *Nitellopsis,* n.l. *N. sarcularis,* en 1 tot *Chara,* n.l. *C. inermis,* en voorts van een aantal nieuwe variëteiten en vormen.

Door bestudering van materiaal en literatuur en een nauwgezet toepassen van de prioriteitsregel konden verschillende nieuwe combinaties en synonymieën worden vastgesteld. Een strenge toepassing van de nomenclatuurregels was mede noodzakelijk door het feit, dat A. BRAUN (1868, p. 795) zich om prioriteit niet bekommerde en een naam ver-

[1]) Een volledige opgave van de hier geciteerde literatuur is te vinden op p. 41.

anderde, wanneer deze niet precies in overeenstemming was met de kenmerken van de plant. Dit gaf enige malen aanleiding tot zeer moeilijk te ontwarren verwikkelingen, b.v. bij *Chara Braunii* GMEL. var. *oahuensis* (MEYEN) ZANEV.

Grote, polymorfe soorten blijken vooral in het geslacht *Chara* niet zeldzaam te zijn. Als zodanig kunnen worden genoemd: *Chara australis* R. BROWN, *Chara Braunii* GMEL., *Chara fibrosa* AG. ex BRUZ. en *Chara zeylanica* WILLD. De door BRAUN als afzonderlijke soorten onderscheiden *Chara Benthamii, C. gymnopitys* en *C. flaccida*, werden als subspecies tot één polymorfe soort, *Chara fibrosa*, verenigd, omdat ze slechts in minstens één belangrijk kenmerk verschillen. In deze bewerking worden voorts als variëteiten beschouwd de exemplaren, die in verscheidene min of meer belangrijke kenmerken van elkaar te onderscheiden zijn, terwijl vormen slechts in één onbelangrijk kenmerk verschillen. Tot „var. typica" en „f. typica" worden gerekend te behoren het type van de soort resp. variëteit en voorts alle individuen, die niet of nauwelijks hiervan te onderscheiden zijn. Omdat bij de *Thallophyta* door de gemakkelijke wijzen van verspreiding de geografie voor de onderscheiding van deze categorieën vrijwel geen houvast biedt, zal men hier in 't bizonder voor de begrenzing van systematische eenheden op o.a. oecologische kenmerken en de resultaten van het experiment aangewezen zijn.

Een bizondere microscopische studie werd gemaakt van de sculptuur van de buitenste membraan van de rijpe oospore, waarbij kwam vast te staan, dat hieraan geen overdreven waarde toegekend mag worden.

De onderverdeling van de geslachten is hoofdzakelijk gebaseerd op de opvattingen van J. GROVES (1924, p. 36; 1935, p. 49), die deze op zijn beurt ontleende aan die van BRAUN en NORDSTEDT (1882). Ook voor de groepen van lagere orde werd de synonymie vastgesteld. Het bleek gewenst in het geslacht *Nitella* de planten met 2—3 cellige eindstralen (dactylae) te verenigen in een nieuwe groep (series), die van de *Heterodactylae*. Voor het geslacht *Chara* was het wenselijk de subsectie *Triplostichae* niet in twee, maar in drie series te splitsen, naar aanleiding van de beschrijving van PAL's *Chara Handae* (1932, p. 86). Deze soort en de reeds vroeger (1906) beschreven *Chara guatemalensis* (NORDST.) C. B. ROBINS. werden dan ook geplaatst in de nieuwe series *Gymnocladia*.

In het Algemene Deel zijn de verschillende gegevens, die ten dele ontleend zijn aan de resultaten van het systematische onderzoek, ten dele aan de aantekeningen op de herbariumetiketten en ten dele aan de bestudeerde literatuur, nader uitgewerkt en wel in een vijftal hoofdstukken, waarbij de nadruk is gelegd op de in Malesië voorkomende soorten.

Hoofdstuk I geeft een historisch overzicht van het onderzoek van de *Charophyta*, die gevonden zijn. Hierbij (§ 1) wordt vastgesteld, dat

de oudste 3 herbariumexemplaren in 1828 door A. ZIPPEL werden verzameld, te weten *Nitella pseudoflabellata* A. BR. ap. NORDST. var. *mutila* A. BR. en *Chara corallina* WILLD. op Amboina en *Nitella microcarpa* A. BR. var. *microglochin* (A. BR.) ZANEV. op Timor. De twee eerstgenoemde soorten worden bewaard in het Rijksherbarium te Leiden, de laatstgenoemde in dat van Berlijn.

De eerste publicatie uit de Archipel (§ 2) verscheen in 1837. Hierin beschreef BLANCO de nieuwe soort *Conferva littoralis*, die later identiek bleek te zijn met *Chara zeylanica* WILLD. f. *armata* (MEYEN) ZANEV. Het oudste exemplaar, dat bestudeerd werd, was verzameld in 1799 bij Tranquebar, Br.-Indië (§ 3) en wordt droog bewaard te Berlijn. Een jaar eerder, 1798, moet op Ceylon door LEBECK, een employé van de Oost-Indische Compagnie, *Chara zeylanica* WILLD. verzameld zijn.

In Hoofdstuk II worden de geografische verspreiding en de verspreidingswijzen behandeld. Aan de hand van tabel I kan de verspreiding van de soorten nagegaan worden. Het blijkt (§ 1), dat van de 24 soorten, die tans voor Malesië bekend zijn, er 18 op Java voorkomen, 10 op Sumatra, 8 op Malakka, 8 op de Philippijnen, 6 op Borneo, 6 op Nieuw-Guinee, 4 op Bali en minder dan 4 soorten op de overige eilanden. Uit deze aantallen volgt, dat de best onderzochte gebieden de meeste soorten hebben opgeleverd, maar tevens is er een aanwijzing in te vinden, dat de verspreiding afhankelijk is van de regenval (§ 3; kaart I).

De verspreiding van de soorten buiten Malesië wordt duidelijk, wanneer de breedtegraden daarbij in ogenschouw genomen worden (zie de indeling op p. 11). Uit tabel II volgt, dat 50 % van de in Malesië voorkomende soorten niet buiten de tropen wordt gevonden, 4 % komt ook in de Zuidelijke gematigde zone voor, 0 % in de Noordelijke gematigde zone en 46 % heeft een nagenoeg cosmopolitische verspreiding. Het is dus niet te verwachten, dat soorten, die benoorden de kreeftskeerkring voorkomen ooit in de Maleise Archipel zullen worden aangetroffen, en omgekeerd zullen soorten, die tussen de keerkringen hun verspreiding hebben, wel niet in de Noordelijke gematigde zone gevonden worden.

Omdat *Charophyta* onder water levende planten zijn en bovendien meestal voorkomen in afgesloten waterbekkens, zal de verspreiding hoofdzakelijk door middel van vogels geschieden (§ 4). Daarbij kunnen vervoerd worden: thallus-fragmenten, de zetmeelhoudende wortel- en okselknolletjes en de oosporen. Behalve vogels kunnen ook zoogdieren de verspreiding bewerkstelligen, zoals blijkt uit de vondst van *Nitella microcarpa* A. BR. var. *microglochin* (A. BR.) ZANEV. in een met water gevulde voetafdruk van een rhinoceros. De genoemde thallus-delen en organen kunnen aan de poten, veren of huid blijven haken en later vrij

komen. Behalve deze exozoische verspreiding, is ook endozoische mogelijk, aangezien de *Charophyta* door verschillende watervogels gegeten worden. Wanneer *Charophyta* in slikvlakten leven, die onder invloed van de getijdewerking van de zee staan, zoals dit bij Bombay het geval is, kan de stroom als verspreidingsfactor optreden.

Hoofdstuk III geeft een nadere toelichting op de klassificatie. Een historisch overzicht wordt hiervan niet gegeven, omdat over dit onderwerp samenvattingen in de literatuur te vinden zijn (zie § 1), evenals over de palaeontologie. De aandacht wordt hier vooral gevestigd op de z.g.n. homologe variaties (§ 3), welke voor 3 van de grootste genera in de tabellen IV t/m VII zijn uitgewerkt. Hieruit volgt, dat verschillende combinaties van kenmerken in enkele gevallen door verscheidene soorten vertegenwoordigd zijn, andere daarentegen door één enkele soort en nog andere in het geheel niet.

Dit kan slechts zeer gedeeltelijk een gevolg zijn van het weinige voorhanden materiaal; voor een ander gedeelte ligt de oorzaak in het feit, dat bepaalde combinaties van potenties, waarvan ieder individu een beperkte hoeveelheid bezit (Lam, 1938), geen levensvatbaar individu geeft. Evenwel zijn hier alleen de morfologische kenmerken opgesomd. Daar het echter de taak van den systematicus is gehéle levenscycli te klassificeren, mogen de oecologische, physiologische, cytologische en genetische eigenaardigheden niet verwaarloosd worden. Eerst wanneer deze bekend zijn, is het mogelijk de taxa nader te definieren.

In Hoofdstuk IV worden de oecologische factoren besproken, die van belang zijn voor het voorkomen in het besproken gebied en waarvan gegevens ter beschikking stonden. Uit een overzicht van de vindplaatsen (§ § 1 en 2, p. 25) blijkt, dat, hoewel het grootste aantal van de beschreven *Charophyta* gevonden wordt in grotere wateren, die niet opdrogen, in kleine wateren, die alleen gedurende het natte seizoen aanwezig zijn, en in rijstvelden, er toch ook een aantal in gelijkmatig, langzaam in dezelfde richting stromend water en in brakwater voorkomt.

Wat de diepte (§ 3) betreft, het blijkt, dat een groot aantal soorten tussen 2 en 8 m voorkomt en een tweetal nog dieper. De maximum diepte zal hoofdzakelijk bepaald worden door de factor licht. Deze factor beïnvloedt tevens de groeivorm en verkort de tijd, benodigd voor het rijp worden van de oogonia, zoals uit de proeven van Karling (1924) en Vouk & Benzinger (1929) bleek. Eenzelfde invloed heeft volgens eerstgenoemde onderzoeker ook de temperatuur. Dat *Charophyta* in staat moeten zijn hoge temperaturen te verdragen, b.v. verscheidene dagen achtereen een temperatuur van 35°—39° C., valt af te leiden uit de waarnemingen van Ruttner (1931).

Uit het overzicht van de hoogten boven zee, waarop *Charophyta*

gevonden zijn (§ 5), volgt, dat een groot aantal boven 1000 m voorkomt. Dit kan verklaard worden uit het feit, dat tot een bepaalde grens de regenval toeneemt met de hoogte (tabel VIII). Verschil in habitus tussen hoog- en laagvlakte-vormen kon, in tegenstelling tot MIGULA (1897), op grond van het onderzochte materiaal niet worden vastgesteld.

Op plaatsen, waar Phanerogamen voorkomen, ontbreken *Charophyta* meestal (§ 6), hetgeen waarschijnlijk een gevolg is van de onderschepping van het licht door eerstgenoemde planten. Epiphytisch zijn vooral aangetroffen *Diatomeae* en *Cyanophyceae,* en voorts soorten van de geslachten *Spirogyra, Chaetophora, Oedogonium* en *Coleochaete.*

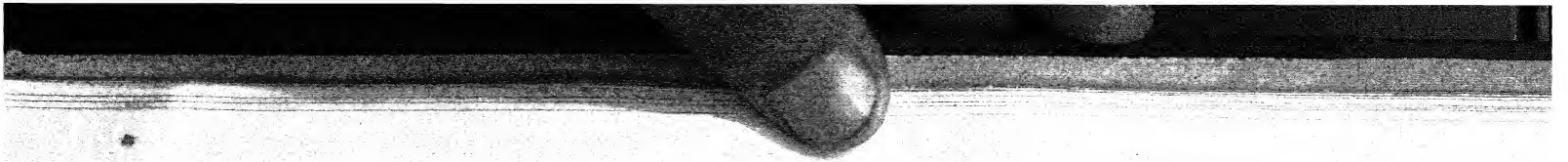
Van de chemische factoren worden kort besproken het chloor-, calcium- en ijzergehalte van het water (§§ 7—9), de opgeloste organische bestanddelen (§ 10), de pH (§ 11) en de aanwezigheid van H_2S (§ 12). Hierdoor is komen vast te staan, dat de meeste *Charophyta* halophobe planten zijn, enkele echter zijn euryhalien (het water bevat 0.1—1.0 g Cl per l), terwijl in Brits-Indië één stenohaliene soort voorkomt, n.l. *Chara canescens* LOISEL. Bij het kalkgehalte van het water komt ook de kalk-incrustatie ter sprake, waarbij gewezen wordt op de causale verklaring van VILHELM (1923, p. 173). Deze auteur wijst op het verband tussen de intensiteit van de koolzuurassimilatie en de grootte van de lichtabsorptie. Wanneer door de assimilatie voldoende CO_2 aan het water wordt onttrokken, zullen de in het water aanwezige bicarbonaten van calcium en magnesium dissociëren en kan $CaCO_3$ neerslaan. Dit kan mede een verklaring zijn voor het feit, dat larven van muskieten niet in wateren, waarin *Charophyta* groeien, voorkomen. SENIOR-WHITE (1926) ontdekte namelijk, dat de larven stierven, nadat zich sphaero-kristallen van $CaCO_3$ op verschillende delen van het lichaam afgezet hadden.

De weinige gegevens omtrent de waterstofionenconcentratie van enkele meren, waarin *Charophyta* gevonden werden, zijn in tabel IX samengesteld. De getallen duiden er mogelijkerwijze op, dat soorten van het geslacht *Nitella* in zuurder water voorkomen dan die van het geslacht *Chara.*

Hoofdstuk V bevat enkele aanwijzingen over de economische betekenis van de *Charophyta.* Dat deze gering is, blijkt reeds uit het geringe aantal volksnamen, dat bekend is (§ 1). Door het assimilerend vermogen wordt veel zuurstof aan het water toegevoegd, waarom de *Charophyta,* evenals andere submerse planten voor visvijvers aan te bevelen zijn (§ 2). Bovendien zoeken een groot aantal insekten, kreeftachtigen en slakken beschutting in de dichte wiermassa's, waardoor ze een goede voedselbron voor vissen vormen. Volgens BACKER

(1911) worden algen, incl. *Charophyta*, uit het Tobameer als varkensvoedsel gebruikt (§ 4). In Amerika worden, volgens MACATEE (1915), de zetmeelhoudende wortelknolletjes als voeder voor eenden gebruikt, een goedkoop voedsel, dat voor de vele eendenfokkerijen in Indië aanbevolen kan worden. Op Bali worden de gedroogde *Charophyta* en andere algen, naar Prof. THIENEMANN meedeelde (§ 5), waarschijnlijk gebruikt als mest. In verband hiermede werd in de tabellen X en XI een overzicht gegeven van de chemische samenstelling van twee verschillende *Chara*-soorten. Hieruit blijkt, dat het kalkgehalte zeer hoog is, waardoor het gebruik van *Charophyta*-débris sterk aanbevolen kan worden teneinde zure gronden te neutraliseren. Mogelijk zijn grote hoeveelheden van deze *Charophyta*-débris op de bodem van verscheidene meren in onze Archipel aanwezig, daar SCHUETTE en ALDER (1929) berekenden, dat jaarlijks in Lake Wisconsin (U.S.A.) alleen door *Charophyta* 993000 kg calciumcarbonaat worden afgezet. Dit meer heeft een oppervlakte van 30 km² en een gemiddelde diepte van 50 m. De voor de vegetatie benodigde hoeveelheden bedragen 397000 kg calcium en 427000 kg CO_2.

Na nog gewezen te hebben op enkele manieren, waarop in andere landen (§ § 6—9) *Charophyta* gebruikt worden, wordt tenslotte stil gestaan bij de vermeende toxische werking van deze algen (§ 10). De lijst van de geaardheid van de vindplaatsen (Hoofdstuk IV, § 1) van *Charophyta* komt nagenoeg overeen met die, welke RUSSELL en BAISAS (1934) geven voor de broedplaatsen van de op de Philippijnen voorkomende larven van *Anopheles*. Ondanks deze morfometrische gelijkheid van de vindplaatsen heeft een aantal onderzoekers, nadat CABALLERO (1924) hierop gewezen had, bevestigd, dat larven van muskieten nooit aangetroffen werden in wateren, waarin *Charophyta* groeiden en omgekeerd. Niettemin toonden SWELLENGREBEL (1924) en anderen aan, dat van een duidelijke larvendodende werking van *Chara vulgaris* L. en andere *Charophyta* niet gesproken kan worden. Een aantal proeven op dit gebied zijn echter waarschijnlijk niet exact genoeg uitgevoerd om een conclusie te kunnen trekken. In verband met het grote belang wordt aanbevolen grondige physische en chemische studies te maken van de wateren, waarin *Charophyta* voorkomen en de resultaten te vergelijken met die van de wateren, waarin muskietenlarven worden gevonden, welke door de onderzoekingen van verschillende in de Philippijnen werkende entomologen en chemici (cf. DE JESUS, 1936) gedeeltelijk reeds bekend zijn. Intussen correleren de weinige gegevens uit tabel IX met die, welke SENIOR-WHITE (1920) in Ceylon voor *Nitella mucronata* (A. BR.) MIQ. en *Chara zeylanica* WILLD. vond.



THE CHAROPHYTA OF MALAYSIA AND ADJACENT COUNTRIES

by

J. S. ZANEVELD

(Rijksherbarium, Leiden)

CONTENTS.

"It is only by a combination of all methods, herbarium or museum, library, laboratory, field, and breeding, that there is any hope of obtaining satisfactory evidence on the nature and genesis of taxonomic units."

W. B. TURRILL in "The New Systematics", 1940, p. 69.

INTRODUCTORY.

The only hitherto known comprehensive studies on the Netherlands Indian *Charophyta* appeared in 1897 and 1899 in the "Prodrome de la Flore Algologique des Indes Néerlandaises", and were compiled by E. DE WILDEMAN. These papers intend to give a mere enumeration of all *Charophyta* published up to 1896, and therefore mainly contain the species recorded by the famous Charaphytologists ALEX. BRAUN and OTTO NORDSTEDT in 1849, 1882, 1888 and 1889.

In the twentieth century only three papers were published on the *Charophyta* of this area, viz. that by DE WILDEMAN (1900), that by GUTWINSKY (1902), and that by FILARSZKY (1934). The first-named author worked up the specimens occurring in Java, the second one adds two species to this list, whereas the latter studied materials collected in 1928 and 1929 by the German Limnological Sunda Expedition.

The present paper intends to give a taxonomical survey of the

Charophyta of the Netherlands Indies, including some notes on their history, distribution, classification, ecology and economy. The floristic relations in the Archipelago, however, made it desirable to extend this investigation to surrounding countries. I will therefore deal not only with the *Charophyta* occurring in Malaysia, but at the same time with those found in British India (Ceylon incl.), Siam and French Indo-China. As was pointed out by LAM (1937) and defined by VAN STEENIS (1937), the term Malaysia comprises the Malay Archipelago *sensu latiore*, the Malay Peninsula, the Philippines, and New Guinea inclusive.

However, the war made it impossible to study all the types of the species occurring outside Malaysia; therefore, and, at the same time, in order to have an easy survey of the Malaysian species, the former are printed in small type. Moreover, I have mentioned the Australian specimens and their localities for the species occurring in the area under discussion.

I had the opportunity to study a great number of specimens and books, thanks to the kindness of the directors of the herbaria and libraries, whom I tender my sincere thanks for their valuable assistance. In quoting the herbaria in the Taxonomical Part of the present paper I made use of the "International List of Abbreviations" proposed by LANJOUW (1939, p. 142).

BERLIN-DAHLEM, Botanischer Garten und Botanisches Museum	B
BUDAPEST, Sectio Botanico Musei Nationalis Hungarici	Bu-Mus
BUITENZORG, Herbarium en Museum voor Systematische Botanie van 's Lands Plantentuin	Bz
KEW, Royal Botanic Gardens	K
LEIDEN, Rijksherbarium	L
PARIS, Muséum National d'Histoire Naturelle, Laboratoire de Cryptogamie	P
SINGAPORE, Botanic Gardens	Si
STOCKHOLM, Naturhistoriska Riksmuseet, Botaniska Avdelningen	S

The materials put at my disposal mainly consisted of dried specimens, though some of them were preserved in fluid. It may be emphasized that the preservation in alcohol (70 %) or in formalin (1 %) is much more convenient for *Charophyta*; the specimens are less damaged and easier to identify.

Yet, at the end of this study, I feel something of the truth in the words of SALISBURY (1939, p. 404): "When based mainly or entirely on herbarium material monographs are liable to be both a snare and a delusion". Indeed, a real understanding of some species, e. g. *Nitella pseudoflabellata, N. microcarpa, Chara fibrosa, C. vulgaris, C. zeylanica,* is only possible by involving the experiment as well as ecological studies. At the time I was not able to carry these out, but I would reply SALISBURY with the words of TURRILL (1940, p. 69): "No method is sufficient by itself, yet each is essential". In Chapter III, § 4 of the General Part I will refer at some length to this point and to TURRILL's words quoted as a motto.

I am deeply indebted to Dr H. J. LAM, Director of the "Rijksherbarium" and Professor of Systematic Botany at the Government University, Leiden, for his suggestion to work up this interesting group, for his helpful criticism and for the continual sympathy he has shown in the progress of my work. I am also much obliged to my colleagues, members of the staff of the "Rijksherbarium", especially to Dr J. TH. HENRARD, for nomenclatural informations, and to Miss Dr J. TH. KOSTER and Dr S. J. VAN OOSTSTROOM, for their kind assistance in various phases of my investigation. I should like also to thank Miss Dr M. F. E. NICOLAI, Leiden, for kindly reading through the manuscript of Chapter IV.

My sincere thanks are further due to Mr G. O. ALLEN, Godalming, Surrey, England, for the interest with which he followed the advance of this study and for the instructive correspondence concerning some of the species. I have also to thank Mr S. C. DIXIT, Bombay, India, for a duplicate of the type of *Chara pashanii,* and Prof. Dr A. THIENEMANN, Plön, Germany, for informations on the economy.

GENERAL PART

CHAPTER I. History.

§ 1. First collection of Malaysian Charophyta. Though one hundred and one years have elapsed since ALEX. BRAUN stated (1839, p. 310): "Von den ostindischen Inseln, aus China, Japan und Siberien sind noch keine Charen bekannt", the present investigations brought to light that the first *Charophyta* from the Malay Archipelago were collected as early as 1828. In that year, A. ZIPPEL, assistant-curator at "'s Lands Plantentuin", Buitenzorg, took part in an expedition from Batavia via Makassar and Amboina to the S.W. coast of New Guinea (BACKER, 1936). As is mentioned underneath, *Nitella pseudoflabellata* var. *mutila* and *Chara corallina* were collected in Amboina. Obliged to return on account of bad health, ZIPPEL reached S. Timor, where he died in the same year. In this island *Nitella microcarpa* var. *microglochin* was collected. The three specimens mentioned were dried and are still in a good condition, the former two in the "Rijksherbarium" at Leiden, the latter at Berlin.

§ 2. Historical review of the Malaysian Charophyta. Up to the present time no historical review of the identification of the Malaysian *Charophyta* was made. The following notes intend to make an attempt thereto.

The first printed record of any Malaysian Charophyte appeared as long ago as 1837 in the "Flora de Filipinas", in which BLANCO gives a description of a new species *Conferva littoralis*, a "Conferva de playas", which is *Chara zeylanica* f. *armata*. In the second (1845) and third (1879, part 3) edition of BLANCO's Flora the species is still mentioned as a *Conferva*.

The earliest publication on the Netherlands Indian *Charophyta* was, as far as I am aware, by BRAUN in 1849 in HOOKER's "Journal of Botany". Two species are given: *Chara coronata* var. *orientalis*, from Java, which variety was described as new, and *Chara javanica* from Java, described as a new species; the former has now to be named *Chara Braunii* var. *oahuensis* f. *javanica*, and the latter is still a doubtful species, which has never been collected again and the type specimen seems to have disappeared (being, however, most probably

identical with *C. zeylanica*). In 1851, LLANOS, in "Fragmentos de algunas plantas Filipinas no incluidas en la Flora de las islas", described *Chara congesta* as a new species from the Philippines, which appears to be identic with *C. corallina*, at the time being an addition to the *Charophyta* flora. This species is also mentioned in BLANCO's third (1880, part 4) edition. In ZOLLINGER's "Systematisches Verzeichnis" (1854) is added *Chara furcata* ROXB. from Celebes, which later appeared to belong to the genus *Nitella*. WALLMAN, in "Actes de la Société Linnéenne de Bordeaux" (1856), records only *Chara javanica*, but did not give a description of this species either. In 1866, BRAUN, in G. VON MARTENS' "Die Preussische Expedition nach Ost-Asien", mentions two *Charophyta*, both from Borneo, viz. *Nitella pseudoflabellata* (now *N. pseudoflabellata* var. *mutila*) and *N. polyglochin* var. *Zollingeri* (now *N. furcata* var. *Zollingeri*), the former being at the time an addition.

In 1868, in "Monatsbericht der Königlichen Akademie der Wissenschaften, Berlin", BRAUN states that a form of *Nitella acuminata* occurs in Java and in Mindanao. In "Proceedings of the Asiatic Society" (1870), G. VON MARTENS mentions "*Nitella* sp. nov.?", collected by S. KURZ in Java (No. 123); the name for this specimen has to be *N. pseudoflabellata* var. *mutila*.

BRAUN's manuscripts, published after his death by O. NORDSTEDT in "Abhandlungen der Königlichen Akademie der Wissenschaften zu Berlin" (1882), contains the descriptions and some illustrations of the following species: (1) *Nitella acuminata* var. *indica* from Java (now *N. acuminata* var. *subglomerata*), and var. *subglomerata* from the Philippine Islands; (2) *N. axillaris* var. *javanica* from Java (now *N. axillaris*); (3) *N. pseudoflabellata* from Java (now *N. pseudoflabellata* var. *mutila*), and var. *mutila* from Borneo; (4) *N. oligospira* f. *javanica* from Java; (5) *N. polyglochin* var. *Zollingeri* from Soembawa, Celebes, Java and Borneo (now *N. furcata* var. *Zollingeri*) and f. *nicobarica* from the Nicobars (now var. *nicobarica*); (6) *Chara corallina* var.? *basilaris* from the Philippines (now *C. corallina*); (7) *C. coronata* var. *leptosperma* f. *javanica* from Java (now *C. Braunii* var. *oahuensis* f. *javanica*); (8) *C. flaccida* var. *Gaudichaudii* from Celebes and the Marianne Islands, and var.? *oligarthra major* from Borneo (both now *C. fibrosa* ssp. *flaccida*); (9) *C. gymnopus* var. *ceylonica* from Bali (now *C. zeylanica* f. *typica*); the numbers (2), (4), (6), (8) and (9) being new for Malaysia.

In 1888, NORDSTEDT, in "Hedwigia", adds *Nitella oligospira* f. *indica*

from Java and the Nicobars to the list. The same author, in "Lunds Universitets Årsskrift" (1889), describes the decoration of the outer coloured membrane of the oospores of some of the known species, whereas *Chara gymnopitys* var. "*α*" (now *C. fibrosa* ssp. *gymnopitys* var. *typica*) from New Guinea is added. In 1889 again, NORDSTEDT, in "Die Forschungsreise S. M. S. 'Gazelle', IV. Th., Bot.", describes *Nitella acuminata* from Amboina (now *N. acuminata* var. *Bélangeri*), *N. polyglochin sens. lat.* (now *N. microcarpa* var. *microglochin*) from Timor, *Chara gymnopitys* f. *longibracteata* (now *C. fibrosa* ssp. *gymnopitys* var. *typica*) from Timor, and *C. brachypus* from Timor; *N. microcarpa* var. *microglochin* and *C. brachypus* being additions. To "*C. gymnopitys*" NORDSTEDT has added that it is distributed "im östlichen Afrika, im Ostindien, Borneo, auf den Mariannen und Celebes". It is noteworthy that this is the distribution of "*C. flaccida*" as cited in the "Fragmente" (1882, p. 129), which is the only publication from which the distribution could be taken. I therefore deem it most probable that NORDSTEDT has erroneously cited the distribution of *C. fibrosa* ssp. *flaccida* under *C. fibrosa* ssp. *gymnopitys*.

DE WILDEMAN, in "Prodrome de la Flore Algologique des Indes Néerlandaises" (1897, 1899), summarizes all the then-known *Charophyta* of the Netherlands Indies and gives a table of their distribution; 5 species of *Nitella* and 5 of *Chara* are cited. To these numbers must be added *Nitella microcarpa* var. *microglochin*, as later on *N. polyglochin* was found to comprise both that species and *N. furcata*, and *Chara fibrosa* ssp. *flaccida*, since DE WILDEMAN did not cite it, although it was recorded by BRAUN & NORDSTEDT. No further addition was made to this number by DE WILDEMAN'S "Essai d'une Flore Algologique de Java", published under the title of "Les Algues de la Flore de Buitenzorg" (1900), in which the Javanese *Charophyta* were amply described. Up to 1900 not a single species was recorded from the Malay Peninsula.

Summarizing, we see that at the beginning of the 20th century the following *Charophyta* were known for Malaysia:

Nitella

(1) — *acuminata* var. *Bélangeri*
— — var. *subglomerata*
(2) — *axillaris*
(3) — *pseudoflabellata* var. *mutila*
(4) — *oligospira* f. *javanica*

Chara

(1) — *corallina*
(2) — *Braunii* var. *oahuensis* f. *javanica*
(3) — *fibrosa* ssp. *gymnopitys* var. *typica*
— — ssp. *flaccida*

Nitella	*Chara*
(5) — *furcata* var. *Zollingeri*	(4) — *brachypus*
— — var. *nicobarica*	(5) — *zeylanica*
(6) — *microcarpa* var. *microglochin*	

GUTWINSKI, in the "Bulletin International de l'Académie de Science de Cracovie" (1902), mentions from Java: *Nitella oligospira* f. *indica* and *Chara gymnopitys* or *C. flaccida* (unripe oogonia), both determined by NORDSTEDT (now *C. fibrosa* ssp. *gymnopitys* or ssp. *flaccida*).

In 1912, H. and J. GROVES, in "Philippine Journal of Science", give the first review of the *Charophyta* of the Philippine Islands. Their list contains a number of new records for the Philippines, whereas at the same time *Chara fibrosa* ssp. *Benthamii* is added to the Malaysian *Charophyta* flora. H. GROVES, in "Journal of the Linnean Society, Botany" (1914), records *Nitella acuminata* var. *indica* from British North Borneo (now *N. acuminata* var. *subglomerata*). MERRILL, in his "Species Blancoanae" (1918), mentions from the Philippines: *Chara corallina* and *C. zeylanica* formerly published under the names of *Chara congesta* and *Conferva littoralis* respectively.

In the "Journal of the Straits Branch, Royal Asiatic Society" (1919), RIDLEY gives the descriptions of the *Charophyta* of the Malay Peninsula, as far as I am aware, the first printed records; they are: *Nitella acuminata* (now *N. acuminata* var. *subglomerata*), *N. pseudoflabellata* (now *N. pseudoflabellata* var. *mucosa*), *N. microcarpa* (now *N. microcarpa* var. *microglochin* and var. *Glaziovii*) and *Chara gymnopitys*; *N. pseudoflabellata* var. *mucosa* and *N. microcarpa* var. *Glaziovii* being additions to the Malaysian list. In 1924, J. GROVES, in the "Journal of the Linnean Society, Botany", adds to these *Charophyta* from the Malay Peninsula: *Nitella mucosa* (now *N. pseudoflabellata* var. *mucosa*), *N. microcarpa* (now *N. microcarpa* var. *microglochin*), *N. furcata, Chara flaccida* (now *C. fibrosa* ssp. *flaccida*) and *C. zeylanica,* also recorded from the Andamans and the Cocos Islands, whereas *C. corallina* is only recorded from the S. Andaman Islands.

BISWAS, in the "Journal of the Federated Malay States Museums" (1929), writes that he obtained *Charophyta* from the hotsprings area of Kuala Lumpur, but did not mention the names.

FILARSZKY, in the "Archiv für Hydrobiologie, Suppl. Bd. 12, Tropische Binnengewässer" (1934), describes the *Charophyta* collected by the German Limnological Sunda Expedition and added the following species to the flora of Malaysia: *Nitella sumatrana, N. bipartita* both

from Sumatra, *N. pseudograciliformis* (now *N. mucronata* var. *pseudograciliformis*) from Bali, *Tolypellopsis* (*Nitellopsis*) *simplicissima* from Sumatra (now *Chara australis* var. *Vieillardii* f. *simplicissma*) and *Chara fulgens* from Bali. The other species and forms appear to be identic with already described ones, viz. *Nitella polyglochin* f. *javanica* with *N. furcata* var. *Zollingeri, Chara haitensis* and *C. variabilis* with *C. zeylanica* f. *armata,* and *C. brachypus* f. *robusta* with *C. brachypus.* It must be stated that this is the first publication which contains a good number of ecological data thanks to the investigations of the Sunda Expedition.

The same author, in "Mathematischer und Naturwissenschaftlicher Anzeiger der Ungarischen Akademie der Wissenschaften" (1937), mentions a new *Nitella* for Malay Peninsula, viz. *N. fascicularis,* but the species is insufficiently described and can therefore at present not be added to the Malaysian list.

Surveying the publications of the 20th century up to 1939, to the list of 1900 have to be added:

Nitella

(3) — *pseudoflabellata* var. *mucosa*
(4) — *oligospira* f. *indica*
(6) — *microcarpa* var. *Glaziovii*
(7) — *sumatrana*
(8) — *bipartita*
(9) — *mucronata* var. *pseudograciliformis*

Chara

(2) — *Braunii* var. *oahuensis* f. *leptocoronulata*
(3) — *fibrosa* ssp. *Benthamii*
(6) — *fulgens*
(7) — *australis* var. *Vieillardii* f. *simplicissima*

The Taxonomical Part of the present paper contains the descriptions of 12 species of *Nitella,* 1 species of *Nitellopsis* and 11 species of *Chara* occurring in Malaysia, whereas a good number of varieties and forms (partly new) are described. In total, to the list 3 *Nitella* species are now added, viz. *N. moniliformis,* n. sp., *N. tumulosa,* n. sp., and *N. Alleninda,* n. sp., further 1 *Nitellopsis* species, viz. *Nitellopsis sarcularis,* n. sp., and 4 *Chara* species, viz. *C. hydropitys, C. inermis,* n. sp., *C. erythrogyna* and *C. globularis,* the last two with some doubt, as I did not see the original specimens.

§ 3. First collection and record of Indian Charophyta. According to BRAUN (1849, p. 300), the first Charophyte of India, *Chara zeylanica,* was collected in Ceylon in 1798 by LEBECK, an official of the E. India Company.

The oldest specimen which came under the eyes of the writer was *Chara corallina*, being collected in 1799 at Tranquebar at the Coromandelian coast without mention of the collector's name. The specimen is dried and is preserved in a good state in the Berlin herbarium. This species was collected together with *Chara setosa* (now *C. brachypus*) and *C. zeylanica*, as was shown in the first paper dealing with Indian *Charophyta*, entitled: "Ueber die Gattung *Chara*". This paper was published by WILLDENOW in 1806 in "Sammlung der deutschen Abhandlungen welche in der Königlichen Akademie der Wissenschaften zu Berlin vorgelesen worden in den Jahren 1803". The French translation of this paper, however, bears on the frontispiece as year of publication 1805!

CHAPTER II. **Distribution and dispersal.**

§ 1. Distribution of the Malaysian and Indian Charophyta. The species composing the *Charophyta* flora of Malaysia are heterogeneous in origin. Some of the species have come to the richest display of their potentialities in Malaysia, while others have their main distribution in more northern or southern areas. Especially the Malay Archipelago, situated at either side of the equator between the Asiatic and Australian continents, may be expected to be a meeting place of northern and southern species, some of which reach their boundaries here. Though it is at present impossible to obtain a real understanding of the origin of the Malaysian *Charophyta* flora, some remarks on this subject may be of interest.

For this purpose table I was established, showing the distribution of the *Charophyta* described in this paper inside as well as outside the area under discussion. The primary difficulty for a non-monographer in compiling such a statement is that many authors do not accept the same delimitation for the same species. Another point is that he has to follow without possible criticism the statements given in literature. In view of the last objection different signs are used, explained at the base of the table mentioned.

For the indication of the districts in Malaysia in table I and in the Taxonomical Part the "Lijst van de voornaamste aardrijkskundige namen in den Nederlandsch-Indischen Archipel" (1923) was used, whereas the records from India were arranged with the aid of CLARKE's paper: "On the subsubareas of British India" (1898). The English orthography of the geographical names outside the Netherlands Indian Archipelago is in agreement with "The Oxford advanced Atlas" by

BARTHOLOMEW (1936); for the orthography of the Netherlands Indian names I made use of the above-quoted "Lijst".

As may be seen from table I, 18 species out of the 24 occurring in Malaysia are represented in Java, then follows Sumatra with 10 species, Malay Peninsula and the Philippines with 8 each, Borneo and New Guinea with 6 each, Bali with 4 and the remaining islands with less than 4 species. This sequence is evidently due to the state of exploration of various parts of the Archipelago. It is probable that, when more extensive collections are made especially in the Lesser Sunda Islands and in the Moluccas, not only the given numbers will be better equilibrated, but some more species may be found to occur in Malaysia. In addition, however, this sequence confirms at the same time that the Lesser Sunda Islands with their longer period of drought present less favourable conditions for the growth of *Charophyta* than the Greater Sunda Islands (cf. this Chapter, § 3). At present there is only one collector, the German Limnol. Sunda Expedition excepted, who brought home 8 numbers of *Charophyta*, all others did not collect more than 4 numbers! (cf. index to collectors' numbers). There is, therefore, no reason to lay much stress upon the 5 species, which are hitherto only recorded for one island of the Archipelago only.

It becomes more and more evident that *Charophyta* with a small area are very rare, most of the species having a wide distribution. Of the 61 *Charophyta* mentioned in the present paper 6 are cosmopolitan (*Nitella hyalina, Tolypella glomerata, Chara Braunii, C. contraria, C. vulgaris* and *C. globularis*), while 12 species occur in all continents but one (viz. not in Australia: *Nitella acuminata, N. mucronata, N. tenuissima, Chara canescens, C. aspera* and *C. delicatula*; not in Europe: *Nitella oligospira, N. furcata, N. microcarpa, Chara fibrosa* and *C. zeylanica*; not in Africa: *Nitella batrachosperma*).

Moreover, the table shows that out of the 61 *Charophyta*, 25 are represented in Africa (19 in N. and 19 in S. Africa), 22 in America (20 in N., 14 in C. and 14 in S. America), 17 in Europe and 17 in Australia.

The *Charophyta* flora of Malaysia may be better understood on involving the total area of the species in accordance with the latitude. For that purpose the following list based on the zones of latitude may be of some use, in which the Malaysian species are denoted by an asterisk.

I. *In all parts except the Polar regions* (c. 67°.30′ N. lat.—67°.30′ S. lat.): All cosmopolitan species, and, moreover, **Nitella acuminata,*

**N. pseudoflabellata, N. batrachosperma, *N. oligospira, *N. furcata, *N. mucronata, N. tenuissima, *N. microcarpa, Tolypella prolifera, *Chara fibrosa, *C. hydropitys, C. delicatula* and **C. zeylanica.*

II. *Tropics* (between the Tropic of Cancer and the Tropic of Capricorn, c. 23°.30′ N. lat.—23°.30′ S. lat.): **Nitella axillaris, *N. bipartita, N. patula, N. leptodactyla, *N. tumulosa, *Chara corallina, *C. succincta, *C. erythrogyna, *C. brachypus.*

III. *Northern Temperate* (between the Arctic circle and the Tropic of Cancer, c. 67°.30′ N. lat.—23°.30′ N. lat.): *Nitella tuberculata, N. mirabilis, N. flagelliformis, N. flagellifera, N. Wattii, Tolypella hispanica, Nitellopsis obtusa, Lychnothamnus barbatus, Chara Wallichii, C. canescens, C. aspera, C. infirma, C. connivens.*

IV. *Northern Tropics* (between the Tropic of Cancer and the Equator, c. 23°.30′ N. lat.—0°): **Nitella sumatrana, N. dualis, N. globulifera, N. Annandalei, N. dictyosperma, N. burmanica, N. superba, N. elegans, N. polycarpa, Chara pashanii, C. nuda, C. burmanica, C. Grovesii* and *C. Handae.*

V. *Southern Tropics* (between the Equator and the Tropic of Capricorn, 0°—c. 23°.30′ S. lat.): **Nitella moniliformis, *N. Alleninda, *Nitellopsis sarcularis, *Chara fulgens, *C. inermis.*

VI. *Southern Temperate* (between the Tropic of Capricorn and the Antarctic circle, c. 23°.30′ S. lat.—67°.30′ S. lat.): thus far no species known, with one exception, and this is not surprising, as the land areas in this zone are very small. The exception is **Chara australis*, but its range extends as far northwards as 13° N. lat.

The results of this list will become more striking, if shown in percentages. In table II this is done for two categories separately, viz. the 24 species occurring in Malaysia only and the 37 species occurring in India respectively.

TABLE II.

Zones of latitude / Number of species	I Cosmop.	II Trop.	III N.Temp.	IV N.Trop.	V S.Trop.	VI S.Temp.
Malaysian species (24 = 100 %)	46 %	25 %	0 %	4 %	21 %	4 %
Indian species (37 = 100 %)	22 %	8 %	35 %	35 %	0 %	0 %

This table shows that exactly 50 % of the Malaysian *Charophyta* are recorded for the tropics only (groups II, IV and V), 4 % occurs mainly in the Southern Temperate zone and 46 % has a nearly world-wide distribution. At present no Northern Temperate species is recorded from Malaysia.

Of the Indian species, on the contrary, 43 % is restricted to the tropics only, 22 % is cosmopolitan, 35 % occurs in the Northern Temperate zone only, no species being recorded from the Southern Temperate region.

§ 2. The Origin of the Malaysian Charophyta. Though a definite conclusion must be reserved especially till more is known of the Australian *Charophyta*, it may be seen both from the above statement and from table II that the Malaysian *Charophyta* are purely tropical species, and that it seems improbable that species, occurring north the Tropic of Cancer, may be expected in Malaysia, and conversely, that species which are now mentioned as "endemics" for Malaysia may some time be collected outside the tropics.

The Indian species, on the other hand, have a more northern distribution; it is not very likely that species now recorded as "endemics" are to be found in the Southern Temperate zone; on the contrary, it is rather probable that, if in some other place, they will be collected north of the Tropic of Cancer only.

If all *Charophyta* known at present were classified in this way and if the thus obtained knowledge of their distribution would be considered in combination with the characters of Malaysian species (cf. tables IV—VII) it would be more or less possible to prophesy which species are yet likely to be found in Malaysia.

The percentage of cosmopolitan species is remarkably high and this is doubtlessly due to the easy mode of dispersal.

§ 3. Seasonal distribution. A review of the periods in which the Malaysian *Charophyta* are found is given in table III. For India I may refer to the statements of G. O. ALLEN (1925, pl. 5; 1928, p. 66) and PAL (1932, p. 51).

The main factor for the seasonal distribution of the *Charophyta* is water and, occasionally, the rainfall. In agreement herewith, table III shows that, as a whole, *Charophyta* with ripe oospores have been found for the greater part between February and May, i. e. some months after the onset of the wet monsoon. However, the area under discussion is too extensive to allow generalization, as the distribution of the rainfall throughout the year differs, of course, for the dif-

TABLE III.

Seasonal distribution of the Malaysian *Charophyta* [1]).

Species	Distribution [2])	Oct.	Nov.	W.(wet) monsoon Dec.	Jan.	Feb.	Mar.	Apr.	E.(dry) monsoon May	Jun.	Jul.	Aug.	Sep.
Nitella													
- acuminata	M.P.,S.,J.,Bo.,Ph., A.												
- sumatrana	S.												
- axillaris	J.												
- bipartita	S.,J.												
- pseudoflabellata	M.P.,S.,J.,Bo.,A., N.G.												
- moniliformis	J.												
- oligospira	A.& N.,M.P.,J.,N.G.												
- tumulosa	N.I.,J.												
- furcata	A.& N. M.P.,J.,B., C.,Ph.,Sw.												
- mucronata	J.,Ba.												
- microcarpa	M.P.,S.,J.,Bo.,C., T.,N.G.												
- Alleninda	J.												
Chara													
- australis	S.,N.G.												
- corallina	A.& N.,S.,J.,Bo., Ph.,A.												
- fulgens	Ba.												
- Braunii	S.,J.,Ph.,L.												
- fibrosa	M.P.,S.,J.,Bo.,C., Ph.,Sb.,T.,K.I.,N.G.												
- hydropitys	M.P.,S.,J.,Ph.												
- inermis	Sb.												
- brachypus	J.,Ph.,Ba.,T.,N.G.												
- zeylanica	A.& N.,M.P.,S.,J., Ph.,Ba.,K.I.												

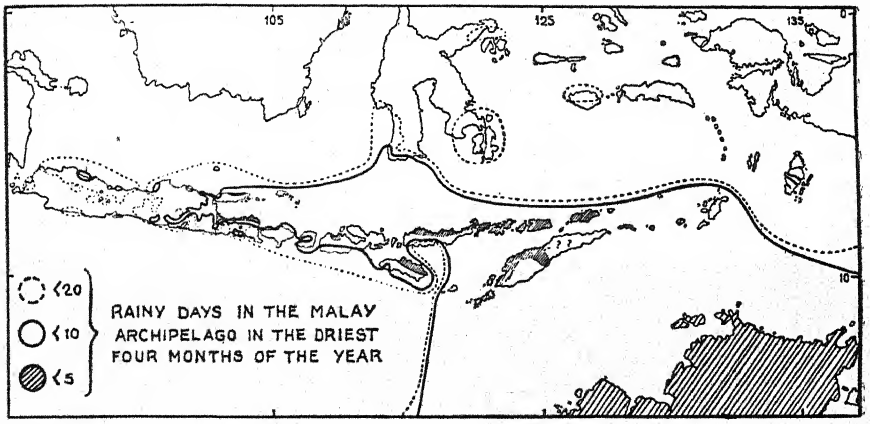
ferent parts of the Archipelago. In this respect the maps of BOEREMA (1924) and BRAAK (1925) are very instructive.

The data of these authors were used by LAM (1934) for the composition of a map partly reproduced in this paper as map I. This map shows the areas in the Netherlands Indian Archipelago with 0—5, 5—10, 10—20 and with more than 20 rainy days in the driest 4 months of the year. It was supposed that more than 20 rainy days in the dry monsoon correspond with at least 2,000 mm rain per year.

[1]) The seasonal distribution of *Nitellopsis sarcularis*, *Chara erythrogyna* and *C. globularis* is unknown.

[2]) In this column the localities quoted in table I are indicated by their initials.

The writer is of the opinion that this amount is sufficient for not too shallow waters to allow a perennial growth of *Charophyta*, on the condition that this amount is equally distributed over the year. On account of this, the areas of *Charophyta* with a long seasonal distribution (cf. table III) may be expected to correspond with the region outside the 20 days line. Now, this is the case with *Nitella acuminata*, *N. pseudoflabellata*, *Chara Braunii*, *C. fibrosa*, *C. hydropitys*, and *C. zeylanica*. These species occur in the Greater Sunda Islands and besides, in Lombok, Soemba and Timor, which are for their greater part situated between the 5 and 10 days lines. Species



Map I. Severity of the dry monsoon in the Malay Archipelago, as indicated by the number of rainy days (from LAM).

with a seasonal distribution of over 5—6 months are *Nitella oligospira*, *N. furcata* and *N. microcarpa*; these occur also in the Greater Sunda Islands and, moreover, in Soembawa and Timor, the latter two lying between the 5 and 10 days lines. However, the correlation mentioned could thus far not be stated for several other species, which occur outside the 20 days line, and yet have a short seasonal distribution. This may be ascribed to the fact that they are recently described ones, viz. *Nitella sumatrana*, *N. bipartita*, *N. moniliformis*, *N. tumulosa*, *N. Alleninda* and *Chara fulgens*.

The conclusion also holds true for the drier regions. Such long-known species as *Nitella axillaris*, *Chara corallina* and *C. brachypus*, whose areas are mainly included between the 10 and 20 days lines, have a short seasonal distribution. *Chara inermis*, nov. spec., at

present only known from Soembawa which lies mainly between the 5 and 10 days lines, was collected with ripe oospores in March, which agrees with the maximum rainfall for this island, viz. in December and February. It must be stipulated that the line encompassing the areas with less than 5 rainy days in the driest 4 months encloses the N. parts of some of the larger Lesser Sunda Islands. In these parts *Charophyta* are hardly to be expected, as well as in the 5—10 days lines area, including the other parts of the Lesser Sunda Islands except a small part of S.W. Flores, S.W. Soemba, S.W. Soembawa, W. Lombok and nearly the whole of Bali, which are less dry.

The small number of species found in the Lesser Sunda Islands is, therefore, not only due to the state of exploration in the Malay Archipelago, but also to the severity of the dry monsoon.

§ 4. Dispersal. *Charophyta* are submerged inhabitants of the stagnant waters and occasionally of slowly running waters. The plants are very fragile and the dispersal by means of fragmentation is very well possible, as the fragments are able to withstand long desiccation (cf. ZANEVELD, 1939, p. 385). Another method of vegetative reproduction is by the starch-bearing bulbils occurring at the lower stem- and root-nodes. As the rooting portions of a plant are very seldom collected, it is often not to be stated with certainty in which species they occur. As far as I know, they are found in the following Indian and Malaysian species: *Chara succincta, C. aspera, C. delicatula, C. vulgaris* and *Nitellopsis obtusa.*

Finally the hard oospores produced in abundant masses at the nodes of the branchlets or at the base of the whorls procure a very important means of dispersal. According to NORDSTEDT (1889, p. 3), the outer membrane is provided with suberin and silicic acid, whereas earlier DE BARY (1875, p. 381) has stated that it is composed of lignin. Fragments with bulbils and mature oospores may get detached, fall into the mud and may thus be transported by the stream. However, this method cannot be an important one, as the plants occasionally occur in these places.

When the species grow in or near an estuary it is possible that the oospores are transported by sea currents. In this connection it is of importance that DIXIT (1931, p. 205) describes *Nitella hyalina, Chara succincta* and *C. zeylanica* from the saltwater mudflats of the island of Salsette (N. of Bombay), which are submerged when the tide is in. Though there are no data available, I deem it most probable that

the oospores do not loose their viability when immersed in sea-water for a fairly considerable time.

As the dispersal by wind is not to be considered, there remains only the dispersal by animals. This must be the primary method for the dispersal of these plants and it is probably effectuated both by means of simple adhesion and of passing through the alimentary canal. The animals involved are, of course, such which regularly visit stagnant waters. According to RIDLEY (1931) these are mainly birds, but also mammals, of which the rhinoceros is marked with certainty. Fragments of the plants, with or without oospores, are eaten by a number of migratory water-fowl such as teal, cormorants, jacanas, herons, sandpipers and ducks; of the latter MACATEE (1915, p. 33) mentions 14 species. The oospores are swallowed and are still germinative after having passed the alimentary canal. In this way the *Charophyta* species can be transported over long distances. In case portions of a plant or whole plants adhere to the fur or feathers of a mammal or a bird, these sooner or later become dislodged and are therefore transported over comparatively small distances only. The same holds true for the adhesion to the feet of an animal in mud in which it has been trampling.

RIDLEY (1919, p. 163) remarks on the herbarium label to *Nitella microcarpa* var. *microglochin* that he found the footprint of a rhinoceros in the middle of the jungle of Gunong Tungal, in the Dindings, on the west coast of the Malay Peninsula, where water had collected, quite filled up with these plants. This species occurred only in rice-fields a few miles away, where the animal had probably picked it up. These animals often wander through the jungle, making a regular round for a month or more, and consequently may carry and distribute the oospores or plant-fragments. The oospores or fragments may occasionally become dislodged and after the rain having filled the hole of their prints, the oospore is able to germinate or the fragments to recover.

The above considerations make it probable that the number of endemic *Charophyta* with a limited area will remain very low.

CHAPTER III. **Classification.**

§ 1. Historical. Up from the earliest epochs, when the species were placed among *Equisetum* and *Hippuris* (DALECHAMPS, 1587, p. 1070; BAUHIN, 1620, p. 25) on account of the more or less similar habit and habitat, till comparatively recent times, when they were considered by HY (1913, p. 4) as belonging to the *Bryophyta*,

the group was subjected to numerous alterations regarding its place in the Vegetable Kingdom, as has been extensively described by WILLDENOW (1805, p. 80), BISCHOFF (1828, p. 23), T. F. ALLEN (1888, p. 9), MIGULA (1897, p. 53), ROBINSON (1906, p. 251), and GROVES & BULLOCK WEBSTER (1920, p. 2). Some additional information may be taken from the synonymy on the division and the family (Taxonomical Part). It would therefore be superfluous to repeat the history here.

GROVES & BULLOCK WEBSTER, in part II of their splendid work "The British *Charophyta*" (1924, p. 72), have added a chapter on the palaeontology of the group, including a list of books and papers, to which I may refer for this subject.

§ 2. Subdivision. The subdivision of the *Charophyta* used in the present paper is mainly based on the opinions of JAMES GROVES (1924, 1935) which in their turn are mainly in accordance with those of ALEX. BRAUN (1835, 1849, 1868, 1882). In *Nitella*, the classification is based on the kind of branchlets in each whorl, the number of cells composing the dactyls, the comparative length of the dactyls, and the presence or absence of mucus around the fertile whorls. In *Tolypella*, the shape of the ultimate cell of the branchlets and rays, and the mode of furcation of the sterile branchlets form important characteristics for the subdivision. The genus *Chara* is mainly subdivided on account of the number of rows of stipulodes and on the disposition of the cortication of the stem and branchlets. The fact whether the plants are dioecious or monoecious is of great importance in all genera. The classification based on these particulars and the few alterations which were added by me, are to be found in the remarks to the genera of the Taxonomical Part.

It appears that, especially in the genus *Chara*, large and polymorphous species are not rare, e. g. *Chara australis*, *C. Braunii*, *C. fibrosa*, and *C. zeylanica*. In addition, BRAUN's species *Chara Benthamii*, *C. gymnopitys* and *C. flaccida* had to be combined as subspecies into one large and polymorphous species (*C. fibrosa*), since intermediate forms occur and since the constituent species are different in one single important character. In the present paper varieties have been distinguished in those cases, in which a number of more or less important characters were extant, and forms, when one characteristic of minor importance could be stated. To "var. typica" and "f. typica" are considered to belong the type specimen of the species or the variety respectively and the specimens which are not or hardly distinguishable from it.

In *Thallophyta* geographical particulars are, as a rule, less important for the delimitation of taxonomic units, owing to the easy mode of dispersal. On account of this, it will probably be more necessary in this group than in the *Cormophyta* to involve e. g. ecological features and experimental methods.

§ 3. Homologous variations. This phenomenon has come into prominence especially after VAVILOV's publication of the "Law of Homologous Series in Variation" (1922, p. 75), being elaborated by him and his school for cultivated plants belonging to the *Gramineae, Cucurbitaceae* and the *Leguminosae,* whereas DIELS (1932) did the same for the *Annonaceae.* For the *Thallophyta,* as far as I know, the attention was only drawn to this peculiarity for the *Fungi,* though the regularity in the participation of the characters in the *Charophyta* species is also obvious. This has given rise to the establishment of identic names for corresponding subdivisions in the same genus. As this is, however, in contradiction to the "International Rules" (Art. 61) some of them had to be changed.

With the aid of the above-cited characters used for the classification and some other ones, the tables IV—VII give a survey of the homologous subdivision in three of the genera best represented in our area.

In table IV (*Nitella*), both the sections *Homoeoclemae* and *Heteroclemae* (in Malaysia only 1 species) are subdivided into groups with one- to more-celled dactyls, and with dioecious and monoecious plants. In both of the latter groups we meet with species with aggregate and solitary gametangia, and in both a mucous cloud around the fertile whorls may be absent or present. However, whereas the section of the *Heteroclemae* has only one representative in our area, the section *Homoeoclemae* is very well represented. In the latter the series *Bicellulatae* has come to the richest display and the *Pluricellulatae* to the poorest, the only species of this series being only very recently detected. Furthermore, table IV shows that the dioecious species are less numerous than the monoecious. Finally I may add that in the Malaysian species of *Nitella* the base of the whorls is always sterile, *Nitella burmanica* and *N. polycarpa* excepted.

It would be very instructive to compare this table with one including all *Nitella* species. However, I have to refrain from such an attempt, as there is no recent monograph. Especially on comparing a complete conspectus with the distribution based on the zones of lati-

TABLE

Homologous variations

Plant	Gametangia \ Mucus	Dactyls: 1-celled, Absent	Dactyls: 1-celled, Present	Dactyls: 1—2- or 1—3-celled, Absent	Dactyls: 1—2- or 1—3-celled, Present
Dioecious	Aggregate	—	*mirabilis*	—	—
	Solitary	—	—	—	—
Monoecious	Aggregate	**acuminata*	—	—	—
	Solitary	—	—	*tuberculata*	**sumatrana*
Dioecious	Aggregate	—	—	—	—
	Solitary	—	—	—	—
Monoecious	Aggregate	—	—	—	—
	Solitary	—	—	—	—

[1]) Malaysian species denoted by an asterisk.

IV.
in *Nitella*[1]).

2-celled		2—3-celled		2—6-celled		Sections
Absent	Present	Absent	Present	Absent	Present	
—	—	—	—	—	—	Homoeoclemae
flagelliformis	*dualis* *globulifera* *Annandalei*	—	*superba*	—	—	
**axillaris* **monoliformis* *burmanica* **furcata* **tumulosa*	—	**mucronata* *polycarpa* **microcarpa*	—	—	—	
**bipartita* **pseudoflabellata* *batrachosperma* *dictyosperma* *flagellifera* *patula* **oligospira*	**pseudoflabellata* *batrachosperma* *leptodactyla* *Wattii*	*tenuissima*	*elegans*	**Alleninda*	—	
—	—	—	—	—	—	Heteroclemae
—	—	—	—	—	—	
—	—	—	—	—	—	
—	*hyalina*	—	—	—	—	

tude, it might be possible to prophesy which species — known or new — may be expected in a certain area.

Table V shows the parallel subdivision for *Tolypella*, and as nearly each of the groups has one representative in our area, the genus

TABLE V.

Homologous variations in *Tolypella* [1]).

Plant / Ultimate cell	Dioecious	Monoecious
Conical	—	*prolifera*
Allantoid	*hispanica*	*glomerata*

TABLE VI.

Homologous variations in the HAPLOSTEPHANAE-ECORTICATAE of *Chara* [1]).

Plant	Base of the whorls / Gametangia	Fertile	Sterile
Dioecious	Aggregate	**australis* *Wallichii*	—
	Solitary	—	**fulgens*
Monoecious	Aggregate	**corallina* *succincta*	**Braunii* *pashanii*
	Solitary	—	*nuda*

[1]) Malaysian species denoted by an asterisk.

TABLE VII.

Homologous variations in *Chara* [1]).

Branchlet-cortex	Stem-cortex / Plant / Gametangia	Haplostichous		Diplostichous		Triplostichous		Sections
		Dioecious	Monoecious	Dioecious	Monoecious	Dioecious	Monoecious	
Absent	Geminate	—	—	—	**fibrosa* **erythro-gyna*	—	—	Haplostephanae-Corticatae
Partially present (diplostichous)	Solitary	—	—	—	*burmanica* **hydro-pitys* [2])	—	—	Haplostephanae-Corticatae
Absent	Geminate	—	—	—	—	—	—	Diplostephanae
	Solitary	—	—	—	*Grovesii*	—	*Handae*	Diplostephanae
Haplostichous	Geminate	*canescens*	—	—	—	—	—	Diplostephanae
	Solitary	—	—	—	—	—	—	Diplostephanae
Diplostichous	Geminate	—	—	—	*contraria*	—	—	Diplostephanae
	Solitary	—	—	—	*vulgaris*	—	**globularis* *delicatula*	Diplostephanae
Triplostichous	Geminate	—	—	—	—	—	—	Diplostephanae
	Solitary	—	—	—	—	*aspera* *infirma* *connivens*	**inermis* **brachypus* **zeylanica*	Diplostephanae

[1]) Malaysian species denoted by an asterisk.

[2]) *C. hydropitys* has sometimes a triplostichous stem-cortex.

may be considered fairly well represented. A peculiarity of the three species occurring in the area under discussion is that the sterile branchlets are all simple, whereas a number of species occurring in North-America have them furcate.

The *Chara* species without a cortex are united in table VI. Within this subsection from either point of view two groups are to be distinguished which are subdivided in the same way.

The corticated *Chara* species are classified in table VII, from which the parallelism in characters is clear. Moreover, it is obvious that dioecious species and those with geminate gametangia are relatively few in number. Aggregated gametangia are not to be found at all and the base of the whorls is always sterile. Table VI, in contradistinction to VII, shows a prominent number of species in which the gametangia are aggregated, the base of the whorls being fertile.

§ 4. Conclusions. Summarizing, we find the fact confirmed that a genus, or in general any group of species, has to be considered a population comprising a certain number of characters or in general of potentialities, of which each individual possesses a limited number only (Lam, 1938, p. 117). Not every combination of potentialities, however, produces a viable "new" species, which may be due to factors of which we know nothing. Therefore, it is possible that some of the empty partitions never will be or have never been filled up. In addition, one or more of the potentialities might have become latent for a longer or shorter period, whereas the circumstances (internal or external) by which they may be reactivated, are entirely unknown.

However, the morphological descriptions of the species only, even if accompanied by their geographical distribution and the variation of their characters provide an incomplete knowledge of the life cycles we try to classify. It is true, the work of classical taxonomists is, as Vavilov (1940, p. 565) says, "basic biological work", but the nature of the species cannot be really understood by this kind of work only. "It is", and I am in full agreement with Turrill's words, quoted as a motto at the heading of this paper, "only by a combination of all methods, herbarium or museum, library, laboratory, field and breeding, that there is any hope of obtaining satisfactory evidence on the nature and genesis of taxonomic units". This is true *a fortiori* for *Thallophyta*, and the hope may be expressed here that detailed ecological, cytological and genetical experiments may be carried out in order to check and eventually correct our present views.

CHAPTER IV. **Ecology.**

The study of the ecology of the *Charophyta* was only started in the last decennium. Especially the papers of STROEDE (1931, 1933) on the German lakes have thrown more light on this subject. In India, PAL (1932) has given some valuable data, whereas in Malaysia nothing has been done in this field of investigation. However, it must be added that valuable physical and chemical data on some of the lakes in Sumatra, Java and Bali were collected by the German Limnological Sunda Expedition in 1928 and described by RUTTNER (1931). It may have some use to discuss the ecological data which have come to my knowledge, as far as they concern the area under discussion. These data are drawn from the label annotations which were scanty and probably in some cases not very accurate either!

§ 1. Types of waters. Though it is, generally speaking, true that *Charophyta* are inhabitants of stagnant, shallow water, the following arrangement gives a number of additional places in which these plants are found in Malaysia.

A. *Stagnant fresh water, not drying up.* — Lakes, ponds, pools, stagnant ditches and moats. Waterholes in rivers and streams, jhils (a "depression below an old river bank", India, U. P.) and raos (torrent beds, India, U. P.). Caldera lakes. Bogs and swamps. Artificial water basins.

B. *Small amounts of fresh water, usually only present during a part of the year.* — Pools in rocks, road-side pools, road-side drains. Temporary rain puddles and hoof prints fitted with water. Kawah pools (pools in crater areas, Malay).

C. *Rice-fields (paddies).* — The fields may be in cultivation or fallow, the water being stagnant or having a hardly perceptible current.

D. *Running waters, moving slowly or with moderate velocity.* — Rivers, streams, canals, tributaries, flowing ditches, creeks, bays. Cataracts basin, rapids, springs.

E. *Brackish waters, stagnant or moving slowly.* — Estuaries, mudflats near the sea-shore, brackish pools, marine fishponds.

§ 2. Water-movements and air. It appears from § 1 that particularly group D, but to a smaller degree also group E, encompasses the species which are not restricted to stagnant water only (lentic environments or standing-water series; WELCH, 1935) or which do not occur in quiet places at all. From the latter group I do not know an example, but Malaysian (denoted by an asterisk) and Indian species that are found in running water (lotic environments) are the following:

**Nitella acuminata* var. *subglomerata, N. globulifera, N. Annandalei, *N. pseudoflabellata* var. *mutila, *N. oligospira* f. *indica, *N. tumulosa, *N. furcata* var. *Roxburghii, *N. microcarpa, N. hyalina, Tolypella prolifera, T. hispanica, Chara Wallichii, *C. Braunii* var. *Braunii* and *var. *Vieillardii, C. nuda, *C. fibrosa, C. Grovesii, C. vulgaris, C. Handae, C. delicatula,* and *C. brachypus.*

As may be seen, the number of *Charophyta* occurring in running water is higher than would generally be expected. However, it must be added that the water motion is a continuous flow in a definite direction, the plants being not subjected to much disturbance. Therefore, the influence of mechanical action may be neglected. *Charophyta,* to my knowledge, are not able to withstand wave movements as surf, etc., which occasionally occur in the littoral zones of larger lakes, nor are they found in canals with much shipping-traffic or in localities where the outlet of factories spoils the water. Therefore in Lake Toba, for instance, *Charophyta* are only found in quiet bights.

On the other hand, moving water leads to a greater activity of the assimilation, as the supply of oxygen is facilitated, whereas at the same time more inorganic nutriment is supplied. *Charophyta* are adapted to live in stagnant water with a relatively low percentage of oxygen, the assimilative surface in contact with water being much enlarged by the many furcations and articulations.

§ 3. Depth and light. Papers frequently mention: "in shallow water", however, many *Charophyta* may have a wide vertical range. In depths from 2—8 metres occur: *Nitella acuminata, N. sumatrana, N. flagelliformis, Nitellopsis obtusa, Chara australis* var. *Vieillardii, C. corallina, C. hydropitys, C. contraria,* and *C. aspera.*

Nitella mucronata and *Chara zeylanica* were found at still greater depths, viz. at 10 and 12 metres respectively. The other *Charophyta* mentioned in the present paper are collected in the shallower water not deeper than 2 m. Here the bottom may sometimes be carpeted by a "cushion" of *Charophyta.*

The plants mentioned above are not restricted to these zones, but may occur occasionally at greater or at smaller depths, due to the fact that every species has its range of tolerance with regard to the intensity of light. Other factors are also of importance, e. g. a stronger movement in the upper layers of the water, the substances dissolved in it and the temperature, but, in my opinion, below the 2 m zone light plays the most important part.

Light intensity diminishes by reflection and by absorption; the

latter being dependent on depth and transparency of the water. Consequently, the intensity of photosynthesis decreases at greater depth. Floating leaves of higher aquatic plants living in the epilimnion may also impede or even prevent the growth of *Charophyta* at a certain depth. These effects were checked by MUKERJI (1932), who found that the *Charophyta* vegetation in Dal Lake (W. Himalaya) is found to a depth of 17 feet, whereas in the Manasbal Lake at the same altitude, but the water of which was 6—8 times clearer (judged with a photometer), the vegetation extends further down to a depth of about 25 feet. *Nitella acuminata, N. flagelliformis, N. hyalina, Nitellopsis obtusa* and *Chara globularis* are able to grow in very low intensities of light.

However, light influences not only the vertical distribution, but also the growth and reproduction. This is clearly shown by the investigations of KARLING (1924), who summarizes the literature concerning this point. KARLING has shown that a few hours of artificial illumination in addition to the daylight are sufficient to induce the development of antheridia and oogonia in mid- and late winter, whereas in nature the plant, with which the experiment was carried out, viz. *Chara globularis,* has (in N. America) ripe oospores from June to September. Moreover, growth under artificial illumination led to the lengthening of the internodes, shortening of the branchlets, etiolation, and a general spindling habit. The same conclusion was also obtained by the experiments of VOUK & BENZINGER (1929).

§ 4. Temperature and drought. The *Charophyta* occurring in the upper layers of deep waters are more exposed both to diurnal and seasonal fluctuations of temperature than those occurring in the lower zones.

In this regard the investigations of RUTTNER (1931, p. 229) on the surface temperature of Ranau Lamongan (E. Java) are of importance. The lake mentioned has an area of about 2 km², therefore the wind action is unimportant. The daily temperature amplitude was measured over a period of 17 successive days in the open water and in a community of *Hydrilla,* floating just below the surface at a distance of 15 m off the shore. The greatest amplitude in the open water was for one day 4°.6 (29°.2—33°.8) C. and in the *Hydrilla* community 11°.8 (28°.3—39°.1) C. Within the period mentioned the temperature in this community was for 3 days 39° C. or more, and for 11 days 35° C. or more.

It is well-known that some *Chara* species have a wide temperature range; e. g. *C. globularis* is recorded both from the hot springs in

Iceland and in Yellowstone Park and from ice water in the "north".

The seasonal fluctuations will be of minor importance since RUTTNER (*l. c.*, p. 403) has shown that in a number of Malaysian lakes the maximum contrast between bottom and surface temperatures was 5°.5 C. In small water basins the temperature affects also the evaporation, by which the concentration of dissolved substances is increased, whereas small pools may disappear altogether. This explains partly why some species have been found in all seasons and others only during a short period, as may be seen from table III. Therefore, in those tropical regions where the rainy season is short, the whole life-cycle of a Charophyte has to be completed within some few months. After the rainy season small pools, etc., will soon dry up and the *Charophyta* of these localities must be able to withstand a long period of drought. The parallelism between rainfall and seasonal distribution is discussed in Chapter II, § 3. It may be added that PAL (1932, p. 53) observed that the rapidly diminishing supply of water hastens the development of sexual organs.

The temperature also acts on the dissolving power of water for gases, as "the colder this is the richer is it in oxygen and carbonic acid, and the more favourable may be the conditions for nutrition and consequently for growth" (WARMING, 1925). In this respect the experiments of KARLING (1924) are of interest, as this author showed for *Chara globularis* that the temperature, within the minimum and maximum limits for vegetative growth, is apparently an indirect factor in determining the production and functional activity of antheridia and oogonia.

§ 5. Elevation. Though many *Charophyta* are recorded from waters occurring in the lowlands, the present investigation shows that a number of species are found in more elevated areas. This is not astonishing as, to a certain limit, rainfall increases with elevation. In

TABLE VIII.

	Tandjong Priok (0 m)	Batavia (7 m)	Mr Cornelis (20 m)	Pasar Minggoe (35 m)	Dèpok (95 m)	Bodjong-gede (148 m)	Buitenzorg (266 m)
mm rain/year	1670	1836	1951	2276	3262	3529	4281

this respect the data of BRAAK (1925, p. 172), reproduced in table VIII are of interest. The table enumerates the annual rainfall for a number of stations situated at an increasing elevation.

According to the altitude of the localities the following groups may be distinguished (0—100 m group omitted):

A. 100—300 m above sea-level. *Nitella acuminata, N. oligospira* f. *indica, N. tumulosa, N. microcarpa.*

B. 300—1,000 m above sea-level. *Nitella bipartita, Chara hydropitys, C. contraria, C. zeylanica.*

C. 1,000—2,000 m above sea-level. *Nitella pseudoflabellata, N. moniliformis, N. mucronata, N. oligospira* f. *javanica, Chara fulgens, C. Braunii, C. vulgaris, C. infirma.*

D. 2,000 m and more above sea-level. *Nitella Alleninda* (2,500 m), *Chara Braunii* var. *oahuensis* (2,000—2,400 m), *Nitellopsis sarcularis* and *Chara brachypus* (c. 2,000 m).

The few label annotations, however, are not sufficient to make conclusions about the occurrence at different altitudes. Whether some species are entirely restricted to a particular altitudinal zone, is not known. PAL (1932, p. 51) writes that *Chara nuda* and *C. Grovesii* never have been found in the lowlands and *C. Wallichii* and *C. hydropitys* never in the mountains.

MIGULA (1897, p. 87) asserts that the *Charophyta* of greater elevation were smaller and more slender than those of the lowlands. I deem it possible that the growth-form of Phanerogams has influenced this author to say so, since I did not see any difference in the species examined by me. This is, of course, plausible as land plants are more closely affected by orographic factors than aquatic ones. Water at great altitudes will be mainly influenced by insolation and temperature.

§ 6. Aquatic community. *Charophyta* mainly grow in localities where no large aquatic plants occur. As was pointed out above, this is probably due to the interception of the light by the floating leaves of these plants. In the area under discussion were found the following *Phanerogamae*: *Potamogeton crispus, P. pectinatus, Najas minor, Hydrilla verticillata, Ceratophyllum demersum, Myriophyllum verticillatum*; *Hydropteridales*: *Marsilia* and *Azolla*; and *Thallophyta* with numerous representatives.

Very often *Charophyta* are overgrown with epiphytes, especially *Diatomeae* and *Cyanophyceae*, but at times the following genera of

Chlorophyceae (among others) may infest them: *Spirogyra, Chaetophora, Oedogonium, Coleochaete.*

§ 7. Cl-content of the water. Most species of *Charophyta* cited under groups A, B, C and D of § 1 (this Chapter), are restricted to fresh water only: they are *halophobous* species. Other ones, however, occur sometimes in the areas of group E, they are *euryhaline* species. As such are to be mentioned: *Nitella hyalina, Nitellopsis obtusa, Chara fibrosa* ssp. *gymnopitys* and ssp. *flaccida, C. hydropitys, C. globularis, C. contraria, C. aspera, C. connivens,* and *C. zeylanica.* In Malaysia no *stenohalinous* species are known, but in India *Chara canescens* is a representative of that group.

Quantitative estimations with regard to a *Charopyta* lake are only known from the lakes investigated by the German Limn. Sunda Exped. These data (cf. RUTTNER, 1931) show that the Cl-content of the water seldom exceeds 0.01 g/l, however, in lake Batoer it is 0.2 g per litre. In this lake *Chara brachypus* was found. In following REDEKE (1922, p. 330; 1936, p. 12), who, at the instigation of NAUMANN (1921, p. 4), projected a "Cl-spectrum", which was adopted by THIENEMANN c. s. (1925, p. 226), the water of this lake must be distinguished as *oligohaline* (0.1—1.0 g Cl/l). Quantitative data outside Malaysia are known for the island of Salsette (North of Bombay), where *Chara succincta* was collected in water with a Cl-content of 15.2 g/l, the water being therefore *polyhaline* (10.0—17.0 g Cl/l). For *Nitella hyalina* and *Chara zeylanica* occurring in the same island, no exact data are mentioned, but DIXIT states that they are collected in a "saltwater mudflat near the sea shore" and in "saline waters" respectively. SENIOR-WHITE (1926, p. 225) mentions the occurrence of *Chara zeylanica* in a drain in Ceylon having a Cl-content of 20.0 g/l, the water being *salt* (> 17.0 g Cl/l).

§ 8. Ca-content of the water. While MIGULA (1897, p. 91) states "Jedenfalls spielt aber der Kalkgehalt der Wässer in Bezug auf die Verbreitung der Charen gar keine Rolle", the investigations of STROEDE (1931, 1933) have shown that some species only grow in fresh water with a certain minimum content of calcium. *Nitellopsis obtusa, Chara delicatula* and *C. globularis,* mentioned in the present paper, were found in Germany in places where the water contained 15—25 mg CaO per litre. *Chara aspera* needs a minimum content of 47 mg/l, *C. vulgaris* of 55 mg/l, *C. contraria* and *Nitella mucronata* of 60 mg/l. As CaO-maximum STROEDE mentions for *Chara vulgaris* 243 mg/l.

Finally it must be added that the experiments of VOUK and

BENZINGER (1929) with *Chara globularis* led to the conclusion that "calcium is indispensable" for that species.

In addition, more attention has been drawn by various authors to the calcareous incrustation. Formerly this was only teleologically explained, viz. in this sense that incrustation would greatly add to the rigidity of the structure and that it would mitigate the influence of too intensive an insolation. However, VILHELM (1923, p. 173) has shown that it is possible to give a causal explanation. The incrustation is, namely, dependent on the factor light, which, in its turn, influences the intensity of the assimilation. The carbon dioxide contained in the calcium hydrogen carbonate, is seized by the assimilating *Charophyta*, whereas the $CaCO_3$ is excreted on their surfaces. Consequently, the quantity of this excretion is largely dependent on the light intensity.

Furthermore, the more flexible *Nitella* species, for which the incrustation would be more useful than for the corticated and more rigid *Chara* species, are usually less provided with calcium deposits. Moreover, one and the same species is in one locality incrustated and in another one not at all.

The frequently occurring annular incrustation needs further investigation.

§ 9. Fe-content of the water. USPENSKI (1927, p. 48) gives some data with regard to this subject. *Cladophora fracta* and *Oedogonium capillare* grow luxuriantly in water with 0.2 mg Fe_2O_3 per litre, but they collapsed when the Fe_2O_3 content was raised to 0.8 mg/l, under which condition, however, a *Chara* species appeared. The same author states (*l. c.*, p. 88) that *Chara contraria* grows in ponds with 0.2 mg Fe_2O_3 per l, but a *Nitella* species is said to be able to withstand higher contents. In Malaysia RUTTNER (*l. c.*, p. 440) could only state a trace of iron in the lakes Toba, Ranau (both Sum.), Bratan and Batoer (both Bali).

STROEDE (1933, p. 217) has measured the iron-content of some waters in which *Charophyta* occur. His results for the German species, distributed also in the area under discussion, are: *Tolypella nidifica* and *Chara contraria* occur in Fe-oligotrophic water (0.0—0.25 mg Fe_2O_3/l), whereas *Nitella mucronata, Nitellopsis obtusa, Chara delicatula, C. aspera, C. vulgaris* and *C. globularis* are also found in Fe-mesotrophic waters (0.25—1.0 mg Fe_2O_3/l).

§ 10. Organic substances in water. MIGULA (1897, p. 91) already suggested that this factor could be of some importance. STROEDE (*l. c.*, p. 218) has shown that *Tolypella nidifica* and *Nitellopsis obtusa*

do not thrive well in waters with much organic substances, but that they prefer waters with a $KMnO_4$-consumption of less than 10 mg per litre. *Chara delicatula, C. vulgaris* and *C. globularis* prefer waters which are oligo- and mesotrophic with regard to the organic substances (10—25 and 25—75 mg $KMnO_4$/l).

§ 11. pH. All data known about hydrogen-ion concentration of the Malaysian inland waters are collected by the German Limnological Sunda Exped. The data occurring on the labels of the specimens examined by me are united in table IX, though not all of these exactly agree with those mentioned in the paper of RUTTNER.

It follows from table IX that the hydrogen numbers range from moderately low (water acid; pH 5.5) to fairly high (water alkaline; pH 8.7). This was to be expected on account of the considerable quantities of lime with which some of the species are incrustated. However, this incrustation is in *Nitella* by no means as pronounced as in *Chara*. The data of the table are in agreement herewith: in *Nitella* only one value out of four well exceeds the neutral point, whereas in *Chara* only two values out of six are slightly below that point. Although this suggests that most of the *Nitella* species mentioned are moderately to weakly acidophilous plants and those of *Chara* neutrophilous and basophilous, the data are too few to allow generalization. Moreover, I do not know whether the H-ion concentration of the different waters was measured under the same conditions (e. g. hour, depth, etc.).

The pH factor in relation to Burmese *Charophyta* was investigated by PAL (1932, p. 55). The study of this author led him to conclude: "that high pH is favourable to the growth of Charophytes, while a pH below a certain limit (about 8.0) inhibits their growth". This conclusion is not in contradistinction to the data here given, but a minimum pH of 8.0 is certainly too high for the Malaysian species. As to the alkalinity and the conductivity these data are too insufficient to draw any final conclusion.

§ 12. Bottom and H_2S. It is a well-known fact that *Charophyta* occur mostly on a soft muddy bottom and so it is in Malaysia. However, some species are found growing on clay and on fine sand, e. g. *Nitella acuminata, Chara contraria* and *C. brachypus*. *Nitella batrachosperma* was collected in a pool, attached to a mass of decaying filamentous algae.

As far as I know, nothing is known about the chemical composition of the mud in which the Malaysian species have been found to grow. This composition must be of importance, since VOUK and BENZINGER

TABLE IX.

Species \ Physical factors	Surface temp., °C.	pH	Alkalinity	Conductivity	Locality
Nitella					
3. — *sumatrana*	25—27	8.3	1.56	$1.33.10^{-4}$	Lake Toba, Porsea basin (Sum.)
11. — *pseudoflabellata* var. *mutila*	27.5	5.5		$0.06.10^{-4}$	Pool on moor of Hoetagindjang (Sum.)
22. — *furcata* var. *Zollingeri*	25—33	6.5		$0.23.10^{-4}$	Pond at border of Tjiliwoeng (Java)
24. — *mucronata* var. *pseudograciliformis*	22.1	6.8	0.16		Danaubratan, caldera lake near Batoeriti (Bali)
Chara					
1. — *australis* var. *Vieillardii* f. *simplicissima*	25—27	8.3	1.56	$1.33.10^{-4}$	Lake Toba, Porsea basin (Sum.)
4. — *fulgens*	22.1	6.8	0.16		Danaubratan, caldera lake near Batoeriti (Bali)
5. — *Braunii* var. *Braunii* f. *sumatrensis*	22.3	7.5	2.80		Spring marsh near Lake Toba (Sum.)
— *Braunii* var. *oahuensis* f. *leptocoronulata*	16.1	6.7	0.48		Spring basin on Dijèng plateau (Java)
24. — *brachypus*	22.7	8.5	5.80		Danau Batoer, caldera lake on G. Batoer (Bali)
25. — *zeylanica* f. *armata*	27—28	8.7	1.60		Lake Toba, Porsea basin (Sum.)

(1929) have shown that the rhizoids of *Charophyta* represent the main organs of absorption of nutritive materials, whereas the surface of the thallus has in this respect a subordinate function. Further investigation concerning this point would, in my opinion, be desirable.

Most *Charophyta* have a more or less disagreeable smell of sulphuretted hydrogen (very well expressed in the American popular names: "mush grass" and "skunk grass"). The mud of the stagnant pools has retained great quantities of H_2S — according to STROEDE (1931, p. 71; 1933, p. 225) more than 50 mg per litre — mainly produced by anaerobic heterotrophous reduction of sulphates (e. g. *Microspira desulfuricans*) and, moreover, by putrefaction of proteins, for the greater part furnished by decaying *Charophyta* themselves. Parallel with the presence of hydrogen sulphide in the mud and the hypolimnion runs the deficit of oxygen, since the H_2S is oxygenized. When the bottom is ferruginous, iron sulphide is formed, by which the mud is rendered black. The epilimnion is the region of photosynthesis and therefore oxygen is present (BAAS BECKING, 1934, p. 166). However, in times, when assimilation is diminished and the reduction in the hypolimnion becomes more intensive, the oxygen may be substituted by H_2S. Even then, *Charophyta* are able to live under these circumstances, but STROEDE (*l. c.*) has shown for *Nitella mucronata* and *Chara globularis* that these species are not able to endure these conditions longer than some weeks. The data of the water of the pool on the moor of Hoetagindjang (cf. table IX), viz. low pH and few mineral salts, indicate that it was entirely in a "hypolimnic" phase during the time of investigation. This must occasionally be the case in other localities, c.f. e. g. *Nitella pseudoflabellata* var. *mutila* and *Chara fibrosa* ssp. *gymnopitys*, which were collected in "brown peaty water". The *Charophyta* (and other aquatic vegetation) were not able to maintain the oxygen pressure and died when this had reached a certain minimum. In addition, it must be noted that STROEDE (*l. c.*) has shown that for *Charophyta* the presence of H_2S in the mud is not essential.

CHAPTER V. **Economy.**

§ 1. Vernacular names. In Malaysia, just as in other parts of the world, the *Charophyta* are of little economic importance. This is certainly the reason why vernacular names are relatively rare. As such are in use, according to the label annotations: limoet (Bat.,

Daj.), loemoet (Alf., Min., Balin., Jav., Mal.), gagang (Jav.), ganggang (Jav.), ganggeng (Jav., Mal.) and gonggang (Mal.).

The same names, however, are also given by the natives to other submerged aquatic plants, e. g. *Musci*; *Najas falciculata*; *Hydrilla verticillata*; *Ceratophyllum demersum* and *C. submersum*; *Utricularia flexuosa*; cf. BACKER (1911), DE CLERCQ & PULLE (1927), HEYNE (1927). The economic use of these plants, mentioned especially in the paper of the first-named author, are most probably also bearing upon the *Charophyta*.

§ 2. Fish-culture. In the tropics it may often be observed that already in the forenoon the stagnant waters, in which *Charophyta* and other submerged plants grow, are in a state of supersaturation with O_2, shown by the rise of oxygen bubbles to the surface (cf. RUTTNER, *l. c.*, pp. 235, 417); the converse activity, i. e. the oxygen consumption for respiration, being less intensive. As the amount of oxygen dissolved in water is raised by the photosynthesis of green plants, these might for that reason be recommended for use in fish-cultures.

§ 3. Purification of water. The water in which the *Charophyta* grow is always extremely clear. This may at least partly be ascribed to the fact that *Charophyta* are able to purify the water by retaining mud particles between the whorls of their branchlets.

§ 4. Food. A great number of insects, crustaceans, snails and other organisms, take shelter in the dense masses of *Charophyta* and/or feed on them, thus providing a rich supply of food for fishes at the same time. In addition, it must be stated that some fishes make nests among *Charophyta*.

According to BACKER (*l. c.*, p. 514), *Najas tenuifolia* (limoet siarang) is used at Lake Toba as a food for hogs. This lake has a rich *Charophyta* flora and it is very well possible that *Charophyta* are also used for this purpose. Dr BACKER was so kind as to confirm this.

In this connection, it may be of interest that MACATEE (1915) has found that all parts of various *Charophyta* are eaten by 14 species of ducks occurring in North Carolina (U.S.A.). More than 1,100 root-bulbils were observed in the stomach of one single goldeneye and more than 1,500 in that of a pintail. Therefore he recommends *Charophyta* as food for wild duck. In Malaysia too, I think, it would furnish a cheap and readily accessible food, and might therefore be introduced in native breedings of ducks.

§ 5. Manure. FILARSZKY (1934) reproduces a photograph made by Prof. A. THIENEMANN, representing a heap of *Charophyta* at the

bank of Lake Batoer, Kedisan, Bali. These were dredged by the natives, who look in it for snails which are used as a duck's food.

TABLE X.

Chemical analysis of *Chara hispida* dried in air.

Constituent	Percentage	Remarks
Water	5.25	In the ashes for every 1,000 parts 161 are lime and 1.57 phosphoric anhydride.
Pure ashes and silica	47.00	
Crude fat	1.80	
Crude protein	4.37	
Crude cellulose	7.64	
Other carbohydrates	33.94	

TABLE XI.

Chemical analysis of *Chara fibrosa* dried in air and sand-free.

Constituent	Percentage
Ash	41.22
Crude protein (N × 6.25)	4.50
Ether extract	0.76
Crude fiber	9.32
Pentosans	4.70
Nitrogen-free extract	39.50

Constituent of the ash	Percentage
Silica, SiO_2	0.83
Ferric oxide, Fe_2O_3	0.06
Aluminium oxide, Al_2O_3	0.81
Manganomanganic oxide, Mn_3O_4	0.08
Calcium oxide, CaO	37.82
Magnesium oxide, MgO	1.19
Sodium oxide, Na_2O	0.35
Potassium oxide, K_2O	0.58
Chloride, Cl	0.29
Carbonate, CO_3	39.00
Total sulphur, S	0.27
Total phosphorus, P	0.06

Prof. THIENEMANN kindly informed me of his opinion that the *Charophyta* were afterwards spread upon the land as manure. This is also done in several countries in Europe, cf. PROSPER (1910, p. 197) and WASMUND (1933, p. 436).

The importance of using the decayed *Charophyta* for manure or especially for correcting the acidity of soils, may appear from the subjoined analyses of *Charophyta*. In literature mostly the nearly "classical" data of PROSPER (table X) are quoted, but in 1929 SCHUETTE & ALDER have published another analysis, which, however, does not differ much (table XI) from that of PROSPER.

It follows from these tables that the content of calcium oxide and carbonate is very high and it requires no further comment that *Charophyta* debris must be of great importance as lime-manure.

In addition, it must be noted that by the death and decay of *Charophyta* enormous banks are formed at the bottom of the waters from which these plants are not collected for agricultural purposes. SCHUETTE & ALDER (*l. c.*, p. 145) have determined from these analyses that in Green Lake, Wisconsin, the annual growth requirements of *Chara* are for calcium 397 metric tons and for carbon in terms of carbon dioxyde 427 metric tons. To this lake, with an area of c. 30 square kilometres and an average depth of c. 50 metres, every year 993 metric tons of calcium carbonate are returned. These data show that in the numerous lakes of Malaysia considerable masses of this *Chara* marl are possibly still available to be utilized.

At the same time, a minor part is played by the decaying *Charophyta* which are accumulated at the bottom of waters, and by which action the bottom is raised. Therefore the plants may be useful in land reclamation.

§ 6. Polishing-paste. DALECHAMPS, in "Historia Generalis Plantarum", I (1587, p. 1070), cites that the inhabitants of Lyon, France, made use of a plant with the popular name "*Chara*" to polish plates and other domestic utensils. Cf. also DUCHESNE (1836, p. 5).

§ 7. Mud-bathing. PROSPER (1910, p. 201) writes that in Spain in a pool people have bathed, "attributing the cure to their maladies to the action of the deposit of saltpetre on the banks, the 'saltpetre' being the white masses of dry *Chara* which surround the pool". Cf. also WASMUND (1933, p. 508).

§ 8. Therapy. In connection with the foregoing, it may be added that WASMUND (*l. c.*, p. 516) writes that *Charophyta* are sold in

Germany as chemicals, which, when taken, should prevent a number of diseases. It seems not impossible that *Charophyta* in some form are sold in Malaysian druggist's shops.

§ 9. Clarification of sugar. WATT (1899, II, p. 263) quotes ATKINSON, who should state that *Chara involucrata* is used in Bengal to clarify sugar, but WATT has never seen *Chara* so employed. Now ROXBURGH (1832, p. 752) states for *Hydrilla verticillata* that "the Bruhmapoor sugar refiners use this herb, while moist, to cover the surface of their sugars, as clay is used in the West India Islands, and in two or three days the operation is finished exceedingly well". In Malaysia *Charophyta* and other aquatic plants are not reported to be used in the sugar industry, as far as my knowledge goes.

§ 10. Insects. In some parts of Java a plant, named ganggeng or ganggang, is used to lure noxious insects, especially the nauseous-smelling bug, *Leptocorisa varicornis* (walang sangit, Jav.). Bushes of this plant — according to BACKER (*l. c.*, p. 504) *Ceratophyllum* species, but probably also other submerged plants, including *Charophyta*, are in use as they bear the same vernacular name — are attached to a stick which is placed in the rice-fields. The walang sangit then alights upon it and may thus be catched. VAN HEURN (1923, p. 24) is of the opinion that this method does not give satisfactory results.

Special attention must be drawn to the pathology of the imagines of *Diptera*, which show a pronounced preference for certain breeding places. WASMUND (*l. c.*, p. 517) states that species of *Tabanidae*, horse-flies, bred in the heaps of *Charophyta* at the bank of Lake Plön, Germany.

More extensive is the literature on the breeding places of mosquito larvae, which occur in water characterized by certain physical conditions. RUSSELL & BAISAS (1934, p. 298) give a list of the chief types of breeding places of Philippine *Anopheles* larvae. These habitats are nearly the same as for the *Charophyta*, as may appear by comparing the statement of these authors with that in Chapter IV, § 1. KING & DEL ROSARIO (1935, p. 334) state that breeding of *Anopheles* larvae is practically always associated with some kind of aquatic vegetation, usually algae. They cite, among others, a "*Chara*-like plant", which, however, is no Charophyte at all, but a plant belonging to the *Hydrocharitaceae*.

Although the agreement of habitats is very striking, a number of authors have stated that larvae of mosquitoes have never been found in localities where these plants occur. CABALLERO (1919) was the first

who observed this phenomenon, which was later on partly confirmed, but also partly denied after the experiments of SWELLENGREBEL in Holland (1924). For a review of the literature up to 1931, I may refer to STROEDE (1931, p. 88). The theory of CABALLERO was that *Chara vulgaris,* with which this author experimented in Barcelona, produces toxic substances which spread through the water and which were lethal to the larvae of mosquitoes.

In tropical countries the problem was first studied by BLOW (1924, p. 252; 1927, p. 46) in Madagascar (not mentioned by STROEDE). This author came to the conclusion that not the *Charophyta* themselves possess larvicidal properties, but some other substances occurring in the localities of these plants. Moreover, dilute solutions of glucoside from dried *Chara zeylanica* took no effect. *Nitella furcata* var. *Roxburghii, Chara fibrosa* ssp. *gymnopitys* and *C. zeylanica* appear to keep the water quite free of the larvae of *Theobaldia annulata, Culex pipiens,* and *Anopheles maculipennis.*

BUHÔT (1927) experimented with *Nitella phauloteles* and various species of mosquitoes, viz. *Stegomyia fasciata, Culex fatigans,* and *Anopheles nyssorhynchus.* "All gave the same and pleasing results, not laying their eggs upon the surface of the water in the aquarium where the *Nitella* grew". In addition, this author showed that water in which this *Nitella* grew, had no toxical activity on rats, fish and men.

In Burma, PAL (1932) experimented with *Nitella acuminata, N. oligospira* and *Chara fibrosa* ssp. *gymnopitys* and the mosquito *Culex fatigans.* Neither species proved to have any lethal effect on the insects. In nature, however, ponds containing mosquito larvae never contain *Charophyta,* and conversely. PAL arrives at the conclusion that this is due to the occurrence of larvae of *Libellulidae* (dragon flies), which have a greenish tinge or some other protective camouflage. They watch for prey, e. g. mosquito larvae, which often occur between the branchlets of the *Charophyta.* "This would account satisfactorily for the absence of mosquito larvae from waters containing *Charophyta.*"

Summarizing all these experiments, I tend to the opinion that the habitats of *Charophyta* are no favourable breeding places for mosquitoes. The matter is important enough to justify accurate experiments on a larger scale. These experiments must be preceded by exact analyses of the physical and chemical characteristics of the waters in which the *Charophyta* occur, in the way as was started by the German Limnol. Sunda Expedition. For the Philippine mosquito

breeding places such data are available by the experiments of several investigators, cf. DE JESUS (1936), who summarized them. Of these authors I wish to cite SENIOR-WHITE (1926), who investigated the chemical factors of Ceylon breeding places, but also studied in this connection the algal distribution. His data are of special interest as they are well comparable with those mentioned in the present and in the foregoing chapters. SENIOR-WHITE found that mosquito larvae in general only occur at a hydrogen number varying between 5.8 and 8.6, and in waters with a conductivity, varying between 62 and 922 ($\times 10^6$), measured at 25° C. Remarkably enough, this author found that mosquito larvae do not appear to be liable to supersaturation of the water, as fish do; *Anopheles maculatus* was still found in water with 14.84 mg oxygen per litre (the minimum lies at 0.87 mg/l). This state of supersaturation frequently occurs in the stagnant waters, where dense masses of *Charophyta* are found to grow. As is pointed out in § 2, oxygen is formed by photosynthesis and the water may sometimes become highly alkaline caused by the CO_2 consumption by photosynthesis. This is the reason why $CaCO_3$ may be precipitated. In connection with this, SENIOR-WHITE (*l. c.*, p. 233) mentions an important cause of larval mortality. Larvae of *Anopheles listoni* died when the pH under the above mentioned conditions rose to 8.6 and they were found covered by spherical bodies, with a dark centre and a broad translucent edge. What where thought to be the spores of a fungus, appeared to be sphaerocrystals of calcium carbonate. Though the larvae of mosquitoes are surface dwellers, I deem it very well possible that this is another cause for the absence of mosquito larvae from waters in which *Charophyta* are abundant.

The same author (*l. c.*, p. 225) also studied the distribution of algae with regard to the occurrence of mosquitoes. Two *Charophyta* are cited: *Nitella mucronata,* occurring in a tank (pH 6.5—6.6; conductivity 2.00—3.89 $\times 10^{-4}$; oxygen content 2.91—5.64 mg/l), appeared to have nothing to do with the feeding habits of the larvae; and *Chara zeylanica* found in a shallow pool (pH 7.6; conductivity $10.43 . 10^{-4}$), with numerous *Odonata* larvae but only a very few *Culex* larvae. In a drain the same *Chara* species was found (pH 8.1; conductivity $111.91 . 10^{-4}$; c. 3.3 % NaCl), and larvae of *Culex* were more numerous. SENIOR-WHITE considered these data too extreme to draw any conclusions though he tends to a feeding association of certain mosquitoes, mainly *Anophelines,* with certain algae, on the presence of

which that of the mosquitoes probably depends. These data as a whole, agree very well with those cited in table IX.

These few words on this important problem may suffice to show that the end is far from being attained. Definite conclusions on the toxicology of some *Charophyta* species cannot be drawn, but possibly an intensive study of the physico-chemical conditions of their localities may throw some more light on the solution of the malaria-problem.

CHAPTER VI. **Bibliography.**

(The references to the literature made in the Introduction and in the General Part are to be found here; in addition, those papers concerning the Taxonomical Part are enumerated here, which have not been cited at the heading of the species).

AGHARKAR, S. P. & KUNDU, B. C., 1937. Charophytes of Bengal. — Journ. Dep. Sci., Calcutta Univ., N. S. **1**, 1, 1—23, pl. 1—9.

ALLEN, G. O., 1925. Notes on Charophytes from Gonda, U. P. — Journ. Bombay Nat. Hist. Soc. **30**, 3, 589—599, pl. 1—5.

——, 1928. Charophyte notes from Saharanpur, U. P. — Journ. Ind. Bot. Soc. **7**, 2, 49—69, figs. 1—13, pl. 1—6.

——, 1937. Notes on the outer covering of Charophyte fruits. — Journ. Bot. **75**, 153—155.

ALLEN, T. F., 1882. Observations on some American forms of *Chara coronata*. — Amer. Natur. **16**, 358—369, pl. 4, figs. 1, 2, 4—11.

——, 1887. Some notes on Characeae. — Torrey Bot. Cl. **14**, 211—215, 5 pl.

——, 1888—1896. The Characeae of America. — New York. Part I, 1—64, f. 1—54, 1888. Part II, fasc. 1, 1—18, 1892, 14 unnumb. pl. Part II, fasc. 2, 9—17, 1894, 8 unnumb. pl. Part II, fasc. 3, 19—28, 1896, 9 unnumb. pl.

——, 1893. Notes on new Characeae. — Bull. Torrey Bot. Cl. **20**, 119—120.

——, 1896. A new species of *Nitella*, belonging to the *N. flexilis* series, with a review of the allied species. — Bull. Torrey Bot. Cl. **23**, 533, pl. 284.

——, 1896. New species of *Nitella* belonging to the monoecious acuminatae group, with a review of the allied species. — Bull. Torrey Bot. Cl. **23**, 534—536, pl. 285—286.

——, 1894—1898. Japanese Characeae. — Part I, 1894, Bull. Torrey Bot. Cl. **21**, 523—526; Part II, 1895, ibid. **22**, 68—72; Part III, 1898, ibid. **25**, 73—82.

ASCHERSON, P., 1878. Noch einige Bemerkungen über die orientalischen Schismus-Formen und über Pflanzen der kleinen Oase. — Oesterr. Bot. Zeitschr. **28**, 254—257.

BAAS BECKING, L. G. M., 1934. Geobiologie. — 's-Gravenhage, W. P. van Stockum & Zn. N.V.

BACKER, C. A., 1911. Zoetwaterflora en vischteelt. — Teysmannia **22**, 501—515, 751—766.

——, 1936. Verklarend woordenboek van wetenschappelijke plantennamen. — Groningen, P. Noordhoff, N.V.; Batavia, Visser & Co.

BARTHOLOMEW, J., 1936. The Oxford advanced atlas, ed. 5. — Oxford, University Press.

BARY, A. DE, 1871. Ueber den Befruchtungsvorgang bei den Charen. — Monatsb. Kön. Akad. Wiss. Berlin, 227—239, 1 pl.

——, 1875, Zur Keimungsgeschichte der Charen. — Bot. Zeit. 23, 377—385, 393—401, 409—420, pl. 5—6.

BAUHIN, C., 1596. Phytopinax, p. 33. — Bâle.

——, 1620. Prodromus Theatri Botanici, p. 25. — Bâle.

BISCHOFF, G. W., 1828. I. Chareen. Chareae. In: "Die kryptogamischen Gewächse". — Nürnberg, J. L. Schrag, 1—26, pl. 1, 2, 6, f. 1—3.

BISWAS, K., 1929. IV. Papers on Malayan aquatic biology. — Journ. F. M. S. Museums, 14, 404—434, 479—480.

BLANCO, M., 1837. Flora de Filipinas. — Manila, 843—844; ed. 2, Manila 1845, 582—583; ed. 3, 3, Manila 1879, 263; ed. 3, 4, Manila 1880, 91—92.

BLOW, T. B., 1924. Observations on the alleged larvicidal properties of Charophyta. — Journ. Bot. 62, 252—253.

——, 1927. Ibid. — Proc. Linn. Soc. London, 139th Sess., 46—47.

BOEREMA, J., no date. Rainfall types in the Netherlands Indies. — Kon. Magn. Meteor. Observ. Batavia, Verh. 18, 1—103, 2 maps.

BRAAK, C., 1923—1925. Het klimaat van Nederlandsch-Indië. — Kon. Magn. Meteor. Observ. Batavia, Verh. 8.

BRAUN, A., 1835. Uebersicht der genauer bekannten *Chara*-arten. — Flora 18, 1, 49—73.

——, 1839. Ueber den gegenwärtigen Stand seiner monografischen Bearbeitung der Gattung *Chara*. — Flora 22, 1, 308—311.

——, 1844. A brief notice of the Charae of North America. — Amer. Journ. Sci. and Arts 46, 92—93.

——, 1849. Uebersicht der Schweizerischen Characeen. — Repr. from Neue Denkschr. Schw. Gesell. Naturw. 10, 1—23; Abstr. in Flora 32, 130—139.

——, 1849. Characeae australis et antarcticae. — HOOKER's Journ. Bot. & Kew Garden Misc. 1, 193—203.

——, 1849. Characeae Indiae Orientalis et insularum maris pacifici. — HOOKER's Journ. Bot. & Kew Garden Misc. 1, 292—301.

——, 1866. Characeen, in: G. VON MARTENS, Die Preussische Expedition nach Ost-Asien. Bot. Theil. "Die Tange". — Berlin, 143.

——, 1868. Die Characeen Afrika's. — Monatsber. Kön. Akad. Wiss. Berlin von 1867, 782—872.

—— & NORDSTEDT, O., 1882. Fragmente einer Monographie der Characeen (Nach den hinterlassen Manuscripten A. BRAUN's herausgegeben von Dr OTTO NORDSTEDT). — Abh. Kön. Akad. Wiss. Berlin, 1—211, pl. 1—7.

BRITTON, N., 1918. Characeae, in: Flora of Bermuda, p. 504. — New York.

BUHÔT, E. W. I., 1927. Effects on mosquito larvae of a Queensland *Nitella*. — Proc. Roy. Soc. Queensl. 38, N. S., 59—61.

CABALLERO, A., 1919. La *Chara foetida* A. Br., y las larvas de *Stegomyia*, *Culex* y *Anopheles*. — Bol. R. Soc. Espanola Hist. Nat. Madrid 19, 449—455.

——, 1922. Acerca de los efectos de la *Chara* sobre las larvas de los mosquitos. — Bol. R. Soc. Espanola Hist. Nat. Madrid 22, 337—338.

——, 1922. Otras especies larvicidas del genero *Chara*. — Bol. R. Soc. Espanola Hist. Nat. Madrid 22, 418—421.

CLARKE, C. B., 1898. On the subsubareas of British India. — Journ. Linn. Soc., Bot., 34, 1—46, map.

CLERCQ, F. S. A. DE & PULLE, A., 1927. Nieuw plantkundig woordenboek voor Nederlandsch Indië. — Amsterdam, J. H. de Bussy.

DALECHAMPS, J., 1587. Historia Generalis Plantarum 1, p. 1070. — Leiden, 1586—1587.

DIELS, L., 1932. Die Gliederung der Annonaceen und ihre Phylogenie. — Sonderausg. Sitz. ber. Preuss. Ak. Wiss., Phys. Math. Kl., 11, 1—11.

DIXIT, S. C., 1931. Some Charophyta from Salsette. — Journ. Ind. Bot. Soc. **10**, 205—208, figs. 1—3.

DUCHESNE, A., 1836. Répertoire des plantes utiles et des plantes vénéneuses du globe. — Paris, Jules Renouard.

FILARSZKY, F., 1934. Die Characeen der Deutschen Limnologischen Sunda Expedition. — Arch. f. Hydrobiol., Suppl. **12**. Tropische Binnengewässer, **4**, 705—726, figs. 1—80, pl. 24.

——, 1937. Determinatio Characearum Exoticarum. — Math. u. Naturwiss. Anz. d. Ungar. Akad. Wiss. **55**, 476—497, figs. 1—45.

GROVES, H., 1914. Characeae, in GIBBS, L. S., A contribution to the Flora and plant formations of Mount Kinabalu and the Highlands of British North Borneo. — Journ. Linn. Soc., Bot., London, 42, 213.

—— & J., 1912. Characeae from the Philippine Islands. — Phil. Journ. Sci. **7**, 2, 69—70.

GROVES, J., 1922. On Charophyta collected in Ceylon by Mr Thomas Bates Blow. — Journ. Linn. Soc., Bot., **46**, 97—103, pl. 4—7.

——, 1924. Notes on Indian Charophyta. — Journ. Linn. Soc., Bot., **46**, 359—376, pl. 35, 36.

——, 1925. *Chara* and mosquito larvae. — Journ. Bot. **63**, 56.

——, 1931. On the antheridium of *Chara zeylanica* Willd. — Journ. Bot. **69**, 97—98, 1 f.

——, 1935. The primary divisions of the genus *Nitella*. — Journ. Bot. **73**, 46—49.

—— & ALLEN, G. O., 1927. On some Indian Charophyta. — Journ. Bot. **65**, 335—339.

—— & BULLOCK WEBSTER, G. R., 1920—1924. British Charophyta. — Printed for the Ray Soc., London; Part I, 1920; Part II, 1924.

GUTWINSKI, M. R. & NORDSTEDT, O., 1902. In: GUTWINSKI, De algis a Dre M. Raciborski anno 1899 in insula Java collectis. — Bull. Int. de l'Ac. d. Sci. d. Cracovie, 578 (Cl. Sci. Math. et Nat.).

HALSTED, B. D., 1878. Classification and Description of the American species of Characeae. — Proc. Boston Soc. Nat. Hist. **19**, 169—190.

HEUEN, W. C. VAN, 1923. De schadelijke insecten van de rijstplant op Java. — Med. Inst. Plantenz. **61**, 16—25.

HEYNE, K., 1927. De nuttige planten van Nederlandsch Indië. — Ed. 2, Buitenzorg.

HY, F., 1913. Les Characées de France. — Bull. Soc. bot. France **60**, Mém. **26**, 1—47.

JESUS, P. I. DE, 1936. Physicochemical factors in anopheline ecology, I: Studies on nitrogen. — The Phil. Journ. Sci. **59**, 473—491.

KARLING, J. S., 1924. A preliminary account of the influence of light and temperature on growth and reproduction in *Chara fragilis*. — Bull. Torrey Bot. Cl. 51, 469—488, 2 f., pl. 11—13.

KING, W. V. & ROSARIO, F. DEL, 1935. The breeding habits of *Anopheles litoralis* and *A. indefinitus* in salt-water ponds. — Phil. Journ. Sci. 57, 329—349.

LAM, H. J., 1934. Materials towards a study of the flora of the island of New Guinea. — Blumea 1, 1, 115—159.

——, 1937. On a forgotten floristic map of Malaysia (H. Zollinger, 1857). — Blumea, Suppl. 1 (J. J. Smith Jub. Vol.), 176—182, map.

——, 1938. Studies in Phylogeny. I. On the relation of Taxonomy, Phylogeny and Biogeography. — Blumea 3, 1, 114—125.

LANJOUW, J., 1939. On the standardization of herbarium abbreviations. — Chron. Bot. 5, 2/3, 142—150.

Lijst van de voornaamste aardrijkskundige namen in den Nederlandsch-Indischen Archipel, 1923. — 2e Herz. uitgave, Weltevreden, Landsdrukkerij.

LLANOS, A., 1851. Fragmentos de algunas plantas de Filipinas no incluidas en la Flora de las islas. — Manila, 112.

LÜTJEHARMS, W. J., 1938. Christiaan Hendrik Persoon. — Vakbl. v. Biol., 18e jrg., 42—44.

MACATEE, W. L., 1915. Eleven important wild-duck foods. — Bull. U. S. Dept. Agric. 205, 32—35.

MARTENS, G. VON, 1870. Notes on some Javanese Algae. — Proc. Asiat. Soc. Bengal, 183.

MERRILL, E. D., 1918. Species Blancoanae. — Manila, 39—40.

MIGULA, W., 1890—1897. Die Characeen, in: RABENHORST's Kryptogamen Flora von Deutschland, Oesterreich und der Schweiz, 5. — Leipzig.

——, 1930. Ueber einige japanische Characeen. — Hedwigia 70, 211—215, figs. a—f.

MUKERJI, S. K., 1932. Bathymetrical survey of the Dal Lake of Kashmir. — Proc. 19th Ind. Sci. Congr., Bangalore, 328—329.

NAUMANN, E., 1921. Einige Grundlinien der regionalen Limnologie. — Lunds Univ. Årsskrift, N.F. 17, 8, 1—22.

NORDSTEDT, O., 1888. Einige Characeenbestimmungen. — Hedwiga 27, 181—194.

——, 1889. De Algis et Characeis, 3—6. — Lunds Univ. Årsskrift 25, 1—41, pl. 1.

——, 1889. Characeae, in: "Die Forschungsreise S.M.S. Gazelle", IV, Bot. Algers von E. Askenassy, 6—8.

PAL, B. P., 1932. On Burmese Charophyta. — Journ. Linn. Soc., Bot., 49, 47—92.

PROSPER, E. R., 1910. Las Carofitas de Espana. — Madrid.

REDEKE, H. C., 1922. Zur Biologie der Niederländischen Brackwassertypen. — Bijdr. Dierk. 22, 329—335.

——, 1936. On the present state of our knowledge of limnology in the Netherlands. — Union Géodés. e. Géophys. Int. Rapp. div., 1—16.

Règles internationales de la Nomenclature botaniques, 1935. — Jena, G. Fischer.

RIDLEY, H. N., 1919. The fern-allies and Characeae of the Malay Peninsula. — Journ. Roy. Asiat. Soc. Straits Branch 80, 139—164.

——, 1930. The dispersal of plants throughout the world. — Ashford, Kent, L. Reeve & Co.

ROBINSON, C. B., 1906. The Chareae of North America. — Bull. New York Bot. Gard. 4, 244—308.

ROXBURGH, W., 1832. Flora Indica, 3, 563—565. — Serampore, Thacker & Co.

——, 1874. Flora Indica, 647—648. — Calcutta, Thacker, Spink & Co.

RUSSELL, P. F. & BAISAS, F. E., 1934. Habitats of Philippine *Anopheles* larvae. — Phil. Journ. Sci. 55, 297—306.

RUTTNER, F., 1931. Hydrographische und hydrochemische Beobachtungen auf Java, Sumatra und Bali. — Arch. f. Hydrob. Suppl. 8, Trop. Binnengew. 1, 197—454.

SALISBURY, E. J., 1939. The Ecologist appreciates and criticizes the Taxonomist. — Journ. of Ecol. 27, 402—405.

SCHUETTE, H. A. & ALDER, H., 1929. A note on the chemical composition of *Chara* from Green Lake, Wisconsin. — Trans. Wisconsin Acad. Sci. 24, 141—145.

SENIOR-WHITE, R., 1926. Physical factors in mosquito ecology. — Bull. Entom. Res. 16, 187—248.

STEENIS, C. G. G. J. VAN, 1937. On the application of the terms Malaysia and Malaya in plant geography. — Garden's Bull. S. S. 9, 2, 187—189.

STROEDE, W., 1931. Oekologie der Characeen. — Inaug. Diss. 1—119, 6 textf., 2 pl., Berlin, P. Funk.

——, 1933. Ueber die Beziehungen der Characeen zu den chemischen Faktoren der Wohngewässer und des Schlammes. — Arch. f. Hydrobiol. 25, 192—229.

SWELLENGREBEL, H. N., 1924. Over de pogingen tot vernietiging der larven van *A. maculipennis*. — Nederl. Tijdschr. voor Geneesk. 68, 1578—1591.

THIENEMANN, A., 1925. Die Binnengewässer, I, 226. — Stuttgart.

TURRILL, W. B., 1940. Experimental and synthetic plant taxonomy. — The New Systematics, 47—71. — Oxford, At the Clarendon Press.

USPENSKI, E. E., 1927. Eisen als Faktor für die Verbreitung niederer Wasserpflanzen. — Pflanzenforschung, 9, Jena, G. Fischer.

VAVILOV, N. I., 1922. The law of homologous series in variation. — Journ. Genet. 12, 47—89.

——, 1940. The new systematics of cultivated plants. — The New Systematics, 550—566, Oxford, At the Clarendon Press.

VILHELM, J., 1923. Die geographische Verbreitung der böhmischen Charophyten. — Hedwiga 64, 164—174.

VOUK, V. & BENZINGER, F., 1929. Physiology of Charophyta. — Acta Bot. Inst. Bot. Univ. Zagreb, 4, 64—76, figs. 1—4.

WALLICH, N., 1828. A numerical list of dried specimens of plants in the East India Company's Museum. — London (A lithographed list, known as "WALLICH's Catalogue", is extant in the Leiden herbarium).

WALLMAN, J., 1856. Essai d'une exposition systématique de la famille des Characées. — Actes de la Soc. Linn. de Bordeaux 21, Sér. 3, 1—90.

WARMING, E., 1925. Oecology of plants. — Oxford, At the University Press.

WASMUND, E., 1933. Seeablagerungen als Rohstoffe, produktive, technische und medizinische Faktoren. — Archiv. f. Hydrobiol. 25, 423—532.

WATT, G., 1889. A dictionary of the economic products of India, 2, 263. — Calcutta.

WELCH, P. S., 1935. Limnology. — New York & London, McGraw-Hill Book Comp., Inc.

WILDEMAN, E. DE, 1897. Prodrome de la flora algologique des Indes Néerlandaises, 30—31. — Batavia.

WILDEMAN, E. DE, 1899. Ibid., Supplément et tableaux statistiques, 13, 96—99. — Batavia.

——, 1900. Les Algues de la Flore de Buitenzorg. — Flore de Buitenzorg, 3ème partie. Leiden, E. J. Brill, 372—377.

WILLDENOW, C. L., 1805. Du Genre nommé *Chara*. — Mém. Acad. Roy. Berlin p. 1803, 79—90.

——, 1806. Ueber die Gattung *Chara*. — Samml. deutsch. Abh. kön. Akad. Wiss. Berlin f. 1803, 54—62.

ZANEVELD, J. S., 1939. *Nitella madagascariensis*, nov. spec., with notes on the Charophyta of Madagascar. — Blumea 3, 2, 372—387, figs. a—e.

ZOLLINGER, H., 1854. Systematisches Verzeichnis der im indischen Archipel in den Jahren 1842—1848 gesammelten Pflanzen, Heft 1, 4. — Zürich, Kissling.

TAXONOMICAL PART

CHAROPHYTA

Divisio CHAROPHYTA MIGULA, Die Charac., 1897, p. 94; DE WILDEMAN, Alg. Fl. Buitenz., 1900, p. 371; GROVES & BULLOCX WEBSTER, Brit. Charoph. 1, 1920, p. 4; PRINTZ in ENGLER & PRANTL, Nat. Pfl. fam. 3, ed. 2, 1927, p. 412 — *Chareae* BISCHOFF, Krypt. Gew. Deutschl. Schweiz, 1, 1828, p. 24 — *Characeae* SACHS, Lehrb. Bot., ed. 1, 1868, p. 258; T. F. ALLEN, Charac. America 1, 1888, p. 7 — *Charales* OLTMANNS, Morphol. Biol. Alg. 1, ed. 2, 1922, p. 433; DANGEARD, Traité d'Alg., 1923, p. 208.

Subaquatic cell-cryptogams with numerous chloroplasts. Vegetative parts consisting of long internodal cells and short nodal ones, forming the stem and the laterals of limited growth, styled branchlets. These branchlets always produced in whorls originating on the stem-nodes and bearing the gametangia. Sexual reproduction by means of biflagellate spiral-shaped spermatozoids formed in spherical antheridia, and by means of an ovum formed within the oogonium, which is enveloped in five spirally arranged cells. Germination of zygote giving rise to a protonema, from which the mature plant sprouts as a lateral branch. Asexual reproduction lacking. Vegetative reproduction by means of secondary protonemata, starch-bulbils and fragmentation.

Distribution. About 200 species in fresh and brackish water in all parts of the world.

CHARACEAE

Familia CHARACEAE L. C. RICHARD ap. HUMBOLDT & BONPLAND, Nov. gen. spec. Plant. 1, 1815, p. 38; AGARDH, Syst. Alg., 1824, p. XXVII; GRIFFITH, Not. Plant. Asiat., 1849, p. 275; BRAUN in N. Denkschr. Schweiz. Ges. Naturw. 10, 1849, p. 5; KUETZING, Spec. Alg., 1849, p. 513; ZOLLINGER, Syst. Verz. 1, 1854, p. 4 (*nom. tant.*); WALLMAN in Act. Soc. Linn. Bordeaux 21, 1856, p. 8; BRAUN in Monatsb. Kön. Akad. Wiss. Berlin f. 1867, p. 796, 1868 (*nom. tant.*); VON LEONHARDI in Lotos 13, 1863, repr. p. 9 (*nom. tant.*); id. in Verh. naturf. Ver. Brünn 2, 1864, repr. p. 36 (*nom. tant.*); BRAUN in COHN, Krypt. Fl. Schles. 1, 1876,

p. 369; NORDSTEDT in Symb. Soc. Physiogr. Lund., 1878, p. 23 (*nom. tant.*); BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 26 (*nom. tant.*); NORDSTEDT in Forschungsr. S.M.S. "Gazelle", 4. Th. Bot., 1889, p. 6 (*nom. tant.*); MIGULA, Die Charac., 1897, p. 94; DE WILDEMAN, Alg. Fl. Buitenz., 1900, p. 372; H. & J. GROVES in URBAN, Symb. Antill. 7, 1911, p. 30; MERRILL, Spec. Blancoan., 1918, p. 39; RIDLEY in Journ. Straits Branch R. A. Soc. 80, 1919, p. 162; PRINTZ in ENGLER & PRANTL, Nat. Pfl. fam. 3, ed. 2, 1927, p. 412; FRITSCH, Struct. and repr. Alg. 1, 1935, p. 447 — sub *Equisetum* a. o. BAUHIN, Prodr. Theatri Bot., 1620, p. 25 — sub *Phanerogamae* sub *Monoecia Monandria* a. o. SCHREBER ex LINNAEUS, Gen. Plant., 1789, p. 619; PERSOON, Syn. Plant. 2, 1807, p. 530 — ibid. sub *Monandria Monogynia* a. o. WILLDENOW, Fl. Berol. Prodr., 1787 — ibid. sub *Monandria Digynia* a. o. BAUMGARTEN, Fl. Lips., 1790, p. 3 — ibid. sub *Monandria Polygynia* a. o. PURSH, Fl. Amer. sept., 1814, p. 4 — sub *Najas, Ceratophyllum* a. o. A. L. DE JUSSIEU, Gen. Plant., 1789, p. 18; ADANSON, Fam. Plant. 2, 1763, p. 537; REICHENBACH, Fl. Germ. Excurs. 1, 1839, p. 147 — *Gyrophykea* WALLROTH, Fl. Crypt. Germ., 1833, p. 100 — *Chareae* KUETZING, Phyc. Gen., 1843, p. 313; id., Spec. Alg., 1849, p. 513 — sub *Bryophyta* sub fam. *Characeae* HY in Bull. Soc. bot. France 60, 1913, Mém. 26, p. 4 — Ordo *Charales* FRITSCH, Struct. and repr. Alg. 1, 1935, p. 447.

Same characters as the division.

Key to the tribes.

1a. Cells of the coronula in two superimposed rows of five cells each . . . . . I. NITELLEAE

b. Cells of the coronula in one single row of five cells . . . II. CHAREAE

I. NITELLEAE GANT. em. VON LEONH.

Tribus NITELLEAE GANTERER Oesterr. Char., 1847, p. 8, *pro parte*; VON LEONHARDI in Lotos 13, 1863, repr. p. 9; id. in Verh. naturf. Ver. Brünn 2, 1864, repr. p. 36; H. & J. GROVES in URBAN, Symb. Antill. 7, 1911, p. 30; HY in Bull. Soc. bot. France 60, 1913, Mém. 26, p. 5; GROVES & BULLOCK WEBSTER, Brit. Charoph. 1, 1920, p. 95; GROVES in Journ. Linn. Soc., Bot., 1924, p. 360; PRINTZ in ENGLER & PRANTL, Nat. Pfl. fam. 3, ed. 2, 1927, p. 426; PAL in Journ. Linn. Soc., Bot., 49, 1932, p. 64; GROVES & ALLEN in Proc. Roy. Soc. Queensl. 46, 1935, p. 40; ZANEVELD in Blumea 3, 1939, p. 377 — Gen. *Nitella* AGARDH, Syst. Alg. 1824, p. XXVII, *p.p.* A. BRAUN in N. Denkschr. Schweiz. Ges. Naturw. 10,

1849, p. 12; id. in HOOKER's Journ. Bot. 1, 1849, pp. 195, 292; id., Consp. syst. Charac. europ., 1867, p. 1; id. in Monatsb. Kön. Akad. Wiss. Berlin f. 1867, p. 796, 1868 — *Charae epigynae* A. BRAUN in Ann. Sci. Nat., sér. 2, 1, 1834, p. 350; id. in Flora 18, 1835, pp. 12, 49; id. in Linnaea 17, 1843, p. 113 — Fam. *Nitelleae* A. BRAUN in COHN, Krypt. Fl. Schles. 1, 1876, pp. 368, 395; BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 8; T. F. ALLEN, Charac. America 1, 1888, p. 38; G. O. ALLEN in Journ. Bombay Nat. Hist. Soc. 30, 1925, p. 592 — Subfam. *Nitelleae* A. BRAUN ap. MIGULA, Die Charac., 1897, p. 94; ROBINSON in Bull. New York Bot. Gard., 1906, p. 253.

Plants usually not incrusted and then translucent green coloured. *Stem* and *branchlets* entirely without cortical cells. *Branches* similar to the main stem, two or more at a stem-node, originating in the axils of the whorls of branchlets. *Branchlets* usually furcate with one-celled rays, except the ultimate ray (dactyl) which may be more-celled. Cells of the *coronula* in two superimposed rows of five cells each.

Key to the genera.

1a. Antheridia terminal in the furcations of the branchlets; oogonia lateral; oospores elliptic in transverse section . . . . . **1. Nitella**

b. Antheridia and oogonia lateral at the branchlet-nodes; oospores terete in transverse section . . . . . **2. Tolypella**

1. **NITELLA** AG. em. A.BR.

Genus NITELLA AGARDH, Syst. Alg., 1824, p. XXVII, *pro parte*; KUETZING, Phyc. Gen., 1843, p. 318, *pro parte*; WALLMAN in Act. Soc. Linn. Bordeaux 1856, p. 8, *pro parte*; VON LEONHARDI in Lotos 13, 1863, p. 69 (repr. p. 9); id. in Verh. naturf. Ver. Brünn 2, 1864, repr. p. 36; BRAUN in COHN, Krypt. Fl. Schles. 1, 1876, p. 395; BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 28; T. F. ALLEN, Charac. America 1, 1888, p. 38; MIGULA, Die Charac., 1897, p. 95; DE WILDEMAN, Alg. Fl. Buitenz., 1900, p. 374; RIDLEY in Journ. Straits Branch R. A. Soc., 1919, p. 163; GROVES & BULLOCK WEBSTER, Brit. Charoph. 1, 1920, p. 95; J. GROVES in Journ. Linn. Soc., Bot., 46, 1924, p. 360; G. O. ALLEN in Journ. Bombay Nat. Hist. Soc. 30, 1925, p. 592; PRINTZ in ENGLER & PRANTL, Nat. Pfl. fam. 3, ed. 2, 1927, p. 426; PAL in Journ. Linn. Soc., Bot., 49, p. 66; GROVES & ALLEN in Journ. Roy. Soc. Queensl. 46, 1935, p. 40; AGHARKAR & KUNDU in Journ. Dep. Sci., N. S., 1, 1937, p. 2 — *Chara* sect. *Nitella* (AG.) RUPRECHT in Beitr. Pfl. Russ. Reich.

3, 1845, p. 7 — *Nitella* sect. *Furcatae* A. BRAUN in N. Denkschr. Schweiz. Ges. Naturw. 10, 1849, p. 6 — *Nitella* subgen. *Nitella* A. BRAUN in HOOKER's Journ. Bot. 1, 1849, pp. 195, 292 — *Nitella* sect. *Ebracteatae* WALLMAN in Act. Soc. Linn. Bordeaux 21, 1856, pp. 12, 14 — *Nitella* subgen. *Eunitella* A. BRAUN, Consp. syst. Charac. europ., 1867, p. 1; id. in Monatsber. Kön. Akad. Wiss. Berlin f. 1867, p. 796, 1868.

Branches usually two at a stem-node, opposite. *Branchlets* once or more times furcate with more or less equal rays; fertile branchlets frequently contracted into heads. ♂ and ♀ *gametangia* usually sessile, solitary or aggregated, generally not produced at the base of the branchlet-whorls. *Antheridia* terminal, between the furcations of the branchlets, replacing the apical cell of a primary ray. *Oogonia* lateral at the branchlet-nodes, in the monoecious species just below the antheridia, arising from the basal node-cell of the antheridium or of the ray occupying the same place, thus representing a ray of higher order. *Oospores* laterally compressed, hence elliptic in transverse section.

Remarks. I subdivided the genus mainly in accordance with J. GROVES, whose classification was published after his death by G. O. ALLEN (1935, p. 49) and was based on the papers of BRAUN and NORDSTEDT. However, I propose to unite the plants with indifferently 2—3-celled dactyls into a new series of the *Arthrodactylae*, named *Heterocellulatae*. This series has to be inserted between the *Bicellulatae*, with the dactyls strictly 2-celled and the *Pluricellulatae* with the dactyls indifferently 2—6-celled. The classification here followed may be learned from the following review.

I. Sect. *Homoeoclemae*

I. Subsect. *Anarthrodactylae*
II. „ *Heterodactylae*
III. „ *Arthrodactylae*
1. Series *Bicellulatae*
2. „ *Heterocellulatae*
3. „ *Pluricellulatae*

II. Sect. *Heteroclemae*

Distribution. More than one hundred species in fresh and brackish water, in all parts of the world.

Key to the sections.

1a. Branchlets of each whorl nearly uniform and in a single row . . . . . I. HOMOEOCLEMAE

b. Branchlets of each whorl of two distinct kinds and in 2—3 rows . . . . . II. HETEROCLEMAE

Key to the species and varieties [1])

1a. Branchlets of each whorl in a single row and more or less equal (Homoeoclemae) 2
b. Branchlets of each whorl in more than one row and of two distinct kinds (Heteroclemae) . . . . . 31. *N. hyalina*
2a. Dactyls (ultimate rays) strictly one-celled (Anarthrodactylae) . 3
b. Dactyls (ultimate rays) more-celled 5
3a. Plant dioecious; gametangia stalked . . . . . 1. *N. mirabilis*
b. Plant monoecious; gametangia sessile 4
4a. Dactyls of sterile branchlets up to 500 μ long **2a. N. acuminata** var. **Bélangeri**
b. Dactyls of sterile branchlets longer than 650 μ . . . . . **2b. N. acuminata** var. **subglomerata**
5a. Dactyls indifferently 1—2- or 1—3-celled (Heterodactylae) . . 6
b. Dactyls 2- or more-celled (Arthrodactylae) 7
6a. Sterile and fertile branchlets 1—2 times furcate; dactyls indifferently 1—2-celled; oospore membrane granulate . . . . . **3. N. sumatrana**
b. Sterile and fertile branchlets 2—3 times furcate; dactyls indifferently 1—3-celled; oospore membrane tuberculate . . . . . 4. *N. tuberculata*
7a. Dactyls strictly 2-celled (Bicellulatae) 8
b. Dactyls 2—3- or 2—5-celled 31
8a. Plant dioecious; dactyls elongated 9
b. Plant monoecious; dactyls elongated or abbreviated 12
9a. Branchlets 3—5 times furcate; dactyls 1—4 10
b. Branchlets up to 3 times furcate; dactyls 4—6 11
10a. Fertile whorls not enveloped in mucus; ripe oospores 300—350 μ long . . . . . 5. *N. flagelliformis*
b. Fertile whorls enveloped in dense mucus; ripe oospores 160—260 μ long . . . . . 6. *N. dualis*
11a. Branchlets 1—2 times furcate; dactyls shorter than penultimate rays . . . . . 7. *N. globulifera*
b. Branchlets 2—3 times furcate; dactyls longer than penultimate rays . . . . . 8. *N. Annandalei*
12a. Dactyls all much elongated 13
b. Dactyls (at least some of them) much abbreviated 25
13a. Oogonia produced at all free branchlet-nodes 14
b. Oogonia not produced at the first free branchlet-node 20
14a. Branchlets indifferently 1—2 times furcate . . . . . **9. N. axillaris**
b. Branchlets two and more times furcate 15
15a. Branchlets strictly 2 times furcate . . . . . **10. N. bipartita**
b. Branchlets 2—5 times furcate 16
16a. Young fertile whorls not enveloped in mucus 17
b. Young fertile whorls enveloped in mucus 19
17a. Oogonia solitary 18
b. Oogonia 1—3 together . . . . . **12. N. moniliformis**

[1]) Malaysian species in heavy type, those known from Continental Asia in italics.

18a. Plant fairly robust; diam. of the whorls 2 cm and more; antheridia 200—300 μ in diam. . . . . **11b. N. pseudoflabellata** var. **mutila**
b. Plant very minute; diam. of the whorls 0.5 cm; antheridia 175—200 μ in diam. . . . . 13. *N. batrachosperma*

19a. Plant fairly robust, 20—30 cm high; mucous cloud very dense; oospores 290—350 μ long . . . . . **11a. N. pseudoflabellata** var. **mucosa**
b. Plant very minute, up to 10 cm high; mucous cloud very inconspicuous; oospores 225—300 μ long . . . . . 13. *N. batrachosperma*

20a. Young fertile whorls not enveloped in mucus 21
b. Young fertile whorls enveloped in mucus 24

21a. Oospore membrane reticulate 22
b. Oospore membrane granulate 23

22a. Secondary rays 6; a separate little fertile branchlet produced at the first two branchlet-nodes . . . . . **15.** *N. flagellifera*
b. Secondary rays 3—4; no such proliferous branchlets produced . . . . . **14.** *N. dictyosperma*

23a. Oospores c. 225 μ long; inferior cell of dactyls rounded at distal end . . . . . **17.** *N. leptodactyla*
b. Oospores c. 375 μ long; inferior cell of dactyls tapering at distal end . . . . . 16. *N. patula*

24a. Dactyls shorter than penultimate rays; inferior dactylous cell cylindrical and rounded at apex; membrane finely and indistinctly granulate . . . . . **17.** *N. leptodactyla*
b. Dactyls longer than penultimate rays; inferior dactylous cell much curved at base and tapering at apex; membrane vermiformously decorated . . . . . 18. *N. Wattii*

25a. Upper and lower cells of coronula not much varying in length . . . 26
b. Upper cells of coronula much elongated 29

26a. Oogonia solitary . . . . . **19. N. oligospira**
b. Oogonia aggregated 27

27a. Oogonia at base of whorls . . . . . 20. *N. burmanica*
b. Oogonia not at base of whorls 28

28a. Antheridia 300—355 μ in diam.; oospores 340—405 μ long . . . . . **21a. N. tumulosa** var. **typica**
b. Antheridia 230—265 μ in diam.; oospores 245—285 μ long . . . . . **21b. N. tumulosa** var. **pumila**

29a. Sterile branchlets 1—2, fertile branchlets 3 times furcate; oospores up to 220 μ long 30
b. Sterile and fertile branchlets 3—4 times furcate; oospores 225—265 μ long . . . . . **22b. N. furcata** var. **Zollingeri**

30a. Oospores 180—220 μ long . . . . . **22c. N. furcata** var. **nicobarica**
b. Oospores 270—310 μ long . . . . . **22a. N. furcata** var. **Roxburghii**

31a. Dactyls indifferently 2—3-celled (Heterocellulatae) 32
b. Dactyls indifferently 2—5-celled (Pluricellulatae) . . . . . **29. N. Alleninda**

32a. Plant dioecious . . . . . 23. *N. superba*
b. Plant monoecious 33

33a. Dactyls not much abbreviated 34
b. Dactyls all much abbreviated 37
34a. Young fertile whorls not enveloped in mucus 35
b. Young fertile whorls enveloped in mucus . . . . . 26. *N. elegans*
35a. First branchlet-node fertile 36
b. First branchlet-node sterile . . . . . 25. *N. tenuissima* var. *byssoides*
36a. Secondary rays 4—5; tertiary rays 2—4 . . . . . 24a. **N. mucronata**
b. Secondary rays 5—6; tertiary rays 2—5 . . . . . 24b. **N. mucronata** var. **pseudograciliformis**
37a. Oogonia not at base of whorls 38
b. Oogonia at base of whorls . . . . . 27. *N. polycarpa*
38a. Inferior cell of dactyls sub-quadratic; oospores 180—240 μ long . . . . . 28a. **N. microcarpa** var. **microglochin**
b. Inferior cell of dactyls twice as long as wide; oospores longer than 240 μ . 39
39a. Oospores 240—280 μ long. . . . . 28b. **N. microcarpa** var. **Glaziovii**
b. Oospores 300—350 μ long. . . . . 28c. **N. microcarpa** var. **papuana**

I. Sectio HOMOEOCLEMAE J. GROVES in Journ. Linn. Soc., Bot., 46, 1924, p. 360; G. O. ALLEN in Journ. Ind. Bot. Soc. 7, 1928, p. 51; PAL in Journ. Linn. Soc., Bot., 49, 1932, p. 64; GROVES in Journ. Bot. 73, 1935, p. 47; GROVES & ALLEN in Proc. Roy. Soc. Queensl. 46, 1935, p. 40; ZANEVELD in Blumea 3, 1939, p. 378 — Subsect. *Homoeophyllae* A. BRAUN in HOOKER's Journ. Bot. 1, 1849, pp. 195, 196; id., id., 1849, pp. 292, 293; VON LEONHARDI in Lotos 13, 1863, repr. p. 9; id. in Verh. naturf. Ver. Brünn 2, 1864, pp. 36, 38; A. BRAUN, Consp. syst. Charac. europ., 1867, pp. 1, 2; id. in Monatsber. Kön. Akad. Wiss. Berlin f. 1867, pp. 796, 797; BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, pp. 9, 10; T. F. ALLEN, Charac. America 1, 1888, pp. 41, 43; MIGULA, Die Charac., 1897, p. 97; H. & J. GROVES in URBAN, Symb. Fl. Antill. 7, 1911, p. 30; NORDSTEDT in Proc. Roy. Soc. Vict. 31, N. S., 1918, p. 2; PRINTZ in ENGLER & PRANTL, Nat. Pfl. fam. 3, ed. 2, 1927, p. 427 — Subsect. *Homoeoclemae* GROVES & BULLOCK WEBSTER, Brit. Charoph. 1, 1920, p. 110.

Branchlets of each whorl in a single row; all branchlets nearly uniform in length and degree of furcation.

Key to the subsections.

1a. Dactyls (ultimate rays of the branchlets) strictly one-celled . . . . . I. ANARTHRODACTYLAE
b. Dactyls more-celled 2
2a. Dactyls indifferently 1—2- or 1—3-celled . . . . II. HETERODACTYLAE
b. Dactyls 2- or more-celled . . . . . III. ARTHRODACTYLAE

I. Subsectio ANARTHRODACTYLAE GROVES & BULLOCK WEBSTER, Brit. Charoph. 1, 1920, pp. 86, 96; J. GROVES in Journ. Linn. Soc., Bot., 46, 1924, p. 361; PRINTZ in ENGLER & PRANTL, Nat. Pfl. fam. 3, ed. 2, 1927, p. 426; G. O. ALLEN in Journ. Ind. Bot. Soc. 7, 1928, p. 51; PAL in Journ. Linn. Soc., Bot., 49, 1932, p. 64; J. GROVES in Journ. Bot. 73, 1935, p. 49; GROVES & ALLEN in Proc. Roy. Soc. Queensl. 46, 1935, p. 40; ZANEVELD in Blumea 3, 1939, p. 378 — *Nitellae Furcatae* A. BRAUN in HOOKER's Journ. Bot. 1, 1849, p. 195, *pro parte* — Sect. *Monarthrae* A. BRAUN ap. VON LEONHARDI in Lotos 13, 1863, repr. p. 9; id. in Verh. naturf. Ver. Brünn 2, 1874, p. 36; A. BRAUN, Consp. syst. Charac. europ., 1867, p. 1 — Sect. *Monarthrodactylae* A. BRAUN in Monatsber. Kön. Akad. Wiss. Berlin f. 1867, p. 796, 1868, *pro parte*; A. BRAUN in COHN, Krypt. Fl. Schles. 1, 1876, p. 368; BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 9; T. F. ALLEN, Charac. America 1, 1888, p. 41; MIGULA, Die Charac., 1897, p. 97; H. & J. GROVES in URBAN, Symb. Antill. 7, 1911, p. 30; NORDSTEDT in Proc. Roy. Soc. Vict. 31, N. S., 1918, p. 2 — Sect. *Furcinitella* (*Holodactylae*) HY in Bull. Soc. bot. France 60, 1913, Mém. 26, p. 7.

Ultimate rays of the branchlets (dactyls) each consisting of a single cell.

1. Nitella mirabilis NORDSTEDT ex J. GROVES in Journ. Linn. Soc., Bot., 46, 1924, pp. 361, 364, pl. 35; G. O. ALLEN in Journ. Bombay Nat. Hist. Soc. 30, 1925, p. 597, pl. 2, f. 2; GROVES & ALLEN in Journ. Bot. 65, 1927, p. 336; G. O. ALLEN in Journ. Ind. Bot. Soc. 7, 1928, p. 51, pl. 1, f. 2, text-f. 1; id. in Journ. Ind. Bot. Soc. 15, 1936, p. 51.

Plant dioecious, 15—20 cm high; male and female plants similar. *Internodes* somewhat shorter than the branchlets. *Sterile* and *fertile branchlets* similar, 6—8 in a whorl, once furcate. *Dactyls* 2—4, one-celled. ♂ and ♀ *gametangia* aggregated (2—3 together), long stalked and enveloped in mucus. *Antheridia* 500—600 μ in diam., central one sessile, the lateral ones stalked. *Oospores* golden-brown, 375—475 μ long, with 6 broadly flanged ridges. *Membrane* finely granulate.

Remarks. Especially characterized by the aggregated long-stalked gametangia, enveloped in mucus. No specimens examined.

Ecology. Growing in clumps by itself in open water near the margin, on very soft mud.

Distribution. Between 30° N. and 25° N.; ASIA, China: Yunnan; India: Gangetic Plain.

2. Nitella acuminata [1]) A. BRAUN in HOOKER's Journ. Bot. 1,

[1]) The literature and illustrations are cited here and not under the varieties, in those cases, in which an author did not mention to which variety or form a plant belongs.

1849, p. 292; WALLMAN in Act. Soc. Linn. Bordeaux 21, 1856, p. 30; A. BRAUN in Monatsber. Kön. Akad. Wiss. Berlin, 1858, p. 356; BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 35; T. F. ALLEN, Charac. America 1, 1888, p. 41 (*nom. tant.*); H. & J. GROVES in URBAN, Flor. Ind. Occ. 7, 1911, p. 32; RIDLEY in Journ. Straits Branch R. A. Soc. 80, 1919, p. 163; J. GROVES in Philipp. Journ. Sci. 19, 1921, p. 663; id. in Journ. Linn. Soc., Bot., 46, 1922, p. 97; id. in Journ. Linn. Soc., Bot., 46, 1924, pp. 361, 365; G. O. ALLEN in Journ. Bombay Nat. Hist. Soc. 30, 1925, p. 597; GROVES & STEPHENS in Transact. Roy. Soc. S. Afr. 13, 1926, p. 147; G. O. ALLEN in Journ. Bot. 65, 1927, p. 336; id. in Journ. Ind. Bot. Soc. 7, 1928, p. 53; J. GROVES in Journ. Linn. Soc., Bot., 48, 1928, p. 127; PAL in Journ. Burma Res. Soc. 18, 1929, p. 113 (*nom. tant.*); DIXIT in Journ. Ind. Bot. Soc. 10, 1931, p. 205; MIGULA in Hedwigia 70, 1932, p. 211; MUKERJI in Proc. 19th Ind. Sci. Congr., Bangalore, 1932, p. 328; PAL in Journ. Linn. Soc., Bot., 49, 1932, pp. 64, 66; MUKERJI in Proc. 21st Ind. Sci. Congr., Bombay, 1934, p. 295; J. GROVES in Journ. Bot. 73, 1935, p. 46 (*nom. tant.*); AGHARKAR & KUNDU in Journ. Dep. Sci., N. S. 1, 1937, p. 3; ZANEVELD in Blumea 3, 1939, pp. 378, 381 — *Nitella acuminata* var. *indica*; *N. acuminata* var. *indica* f. *brachyteles*, *N. acuminata* var. *javanica*; *N. acuminata* ε *N. Lindheimeri*; *N. acuminata* var. *Lindheimeri*; *N. acuminata* β *N. subglomerata* f. *brachyteles*; *N. Bélangeri*; *N. subglomerata*; *Chara Belangeri*; cf. varieties.

Illustrations[1]). G. O. ALLEN in Journ. Bombay Nat. Hist. Soc. 30, 1925, pl. 2, f. 1; id. in Journ. Ind. Bot. Soc. 7, 1928, f. 2; AGHARKAR & KUNDU in Journ. Dep. Sci., N. S. 1, 1937, pl. 1.

Plant monoecious, bright to brownish green, c. 25 cm high. *Stem* moderately stout, 700—1500 μ in diam. *Internodes* as long as to 1½ times the length of the branchlets. *Sterile branchlets* 6—8 in a whorl, up to 4 cm long, well-developed, in adult specimens curving outwards, once furcate, primary rays $^2/_3$—$^3/_4$ the length of the entire branchlet; secondary rays (dactyls) 2—3, seldom 4, much shorter than the primary rays, extremely variable in length. *Fertile branchlets* frequently in dense heads on separate branchlets of which usually two or three take rise between the sterile whorls; these branchlets sometimes bear not only the compact heads, but also a whorl of 6—8 longer fertile branchlets, c. 1 cm long, whereas the heads are c. 0.2 cm in diam.; both kinds of fertile branchlets are once furcate into 2(—3), short

[1]) Cf. note [1]) on p. 54.

ultimate rays, not enveloped in mucus. *Dactyls* of the sterile branchlets (2—)3, up to 1 cm long, unequal or equal in length, one-celled, at the apex gradually tapering into an acuminate point. The long fertile branchlets have also 2—3 one-celled dactyls, which are much shorter than the sterile ones, being up to 0.2 cm long, and more or less conical; this is also the case in the dactyls of the fertile heads which are 2—4 in number, up to 790 μ long and 125 μ wide at base. ♂ and ♀ *gametangia* together at the same nodes, destitute of gelatinous covering. *Antheridia* solitary, sessile, strictly terminal, 230—310 μ in diam., earlier ripe than the oogonia. *Oogonia* 1—2, seldom 3 together, sessile, lateral, 280—510 μ long (incl. coronula), 240—400 μ wide; *spiral-cells* showing 8—9 convolutions; *coronula* persistent, 33—85 μ high, 45—130 μ wide at base, individual cells strongly converging; *oospores* dark chestnut-brown, subdiaphanous (in dried specimens nearly black), 275—340 μ long, 225—300 μ wide with (6—)7(—8) ridges; *outer membrane* minutely granulate, diaphanous.

Remarks. *Nitella acuminata* is an extremely variable species with an extensive distribution in the tropics and subtropics.

When BRAUN founded this species in 1849, he divided it into three varieties, viz. *Bélangeri* (BRAUN wrote *"Bellangeri"*, cf. this var.) from the coast of Coromandel, *Lindheimeri* from Missouri and Texas, and *mauritiana* from Mauritius. In 1858, BRAUN described two new closely related species from Columbia and Guyana, viz. *Gollmeriana* and *subglomerata*. A first review of the acuminate species belonging to the monoecious monarthrodactylous group was given by BRAUN in his "Characeen Afrika's" (1868, p. 804), in which is primarily stated that *N. Gollmeriana* and an earlier described North-American species *N. glomerulifera* (1844) must be considered as subspecies of *N. acuminata*, whereas *N. subglomerata*, the three varieties distinguished in 1849, and a not named form from Java and Mindanao (in 1882 published as var. *indica*) must be regarded as varieties. In this way it is published in the "Fragmente einer Monographie der Characeen" (1882), in which publication BRAUN again stressed that there are "keine wesentlichen Unterschiede" between *Lindheimeri* and *Bélangeri* and that the var. *indica* is "eine ähnliche mit *N. acum. subglomerata* habituell ganz übereinstimmende Form". The differences between the varieties are based upon: 1. the gametangia being solitary or aggregated, 2. the sterile branchlets being longer or shorter than the fertile branchlets which are contracted into heads, and 3. the comparative length of the primary and secondary rays.

This subdivision was taken over by the eminent specialist of American *Charophyta*, T. F. ALLEN, in 1888. Afterwards (1892, p. 7), however, this author changed his view, also appearing from his review in 1896 (p. 535), in which are cited as separate species, *N. subglomerata* var. *indica, N. mauritiana, N. subglomerata*[1]), *N. glomerulifera*, whereas three new species are added to this already highly variable group, viz. *N. stellaris, N. capitulifera* and *N. subspicata* (*Gollmeriana* is not mentioned at all), mainly separated on account of their smooth oospore membrane, which in the other "species" is granulate or reticulate.

As appears from the literature quotations at the heading of this species most authors of the 20th century have only cited the plants as belonging to *N. acuminata* and did not mention the variety. GROVES (1922, p. 98) argues that the length of the primary rays and the dactyls is extremely variable even in specimens of the same gathering. I can only confirm this, as the specimen from Java in herb. VAN DEN BOSCH has aggregated oogonia, whereas the sterile branchlets are longer than the fertile ones, thus being intermediate between the varieties *Bélangeri* and *indica*.

As I was able to study the types of the last named varieties I could notice a remarkable difference in the length of the dactyls: in *Bélangeri* most of them are hardly macroscopically visible, in *indica*, on the other hand, easily. However, the Concan plant (Bombay) mentioned in 1882 (p. 38) by BRAUN as belonging to var. *Bélangeri* has much longer dactyls and is hardly different from *indica*.

A peculiarity found in the type specimen of *indica* is the presence of geminate oogonia, so that BRAUN's remark (1882, p. 37): "Fructification fehlt" is probably a mistake. The geminate oogonia are doubtless also present in the specimens of VAN DEN BOSCH, reasons why var. *indica* is identic with the earlier published *subglomerata*, which I regard as a variety.

On the other hand, I would unite *N. Lindheimeri* and *Bélangeri* into one variety, under the name of the last one. Most probably T. F. ALLEN's *N. stellaris, N. capitulifera* and *N. subspicata* also belong to our var. *subglomerata*; though I did not see the types I could study the exsiccatae from the herbarium of T. F. ALLEN and the only difference found is the decoration of the oospore membrane, which is indeed

---

[1]) *N. Lindheimeri* inclusive. Probably the var. *Bélangeri* is at the same time included in this species as ALLEN writes (1892, p. 7): "*N. Lindheimer (sic)* A. BR. ... is very closely related to *N. Bélanger (sic)* A. BR.".

quite smooth. Concerning this point it is remarkable that NORDSTEDT (1889, p. 7) states that the membrane is also smooth in young plants of var. *subglomerata* and as the distributed specimens were not fully mature, this peculiarity must be studied again before a decision can be given. The decoration of the oospore membrane alone is not essential enough to maintain specific rank.

N. acuminata differs from the other monoecious *Anarthrodactylae* mainly in having tapering dactyls and a persistent coronula, which are peculiar to *N. flexilis, N. californica, N. mexicana* and *N. laxa*, whereas the likewise acuminate *N. praelonga* has much larger gametangia and the fertile whorls enveloped in mucus.

Ecology. *Nitella acuminata* is a rather robust species, without any trace of incrustation, but it is sometimes covered by clay. It occurs in large masses in rice-fields, road-side pools, ditches, swamps, springs, in open places protected by rushes, and was once recorded from a river.

According to GROVES & ALLEN (1927, p. 336), it is abundant in Saharanpur in the rainy season, but PAL writes (1932, p. 67) that it was only found in Burma after the monsoon was well past. The bottom may consist of clay and of fine sand.

The size of the plants most probably depends on the environmental conditions, as PAL (1932, p. 67) writes that in pools about to dry up the plants were small and stunted, and the fertile branchlets studded with ripe brown oospores, while in the deeper pools close at hand in Burma very stout sterile specimens were found.

MUKERJI (1932, p. 328) records *N. acuminata* from a depth of 7.50 m and states that it appears to possess great powers of tolerating very low intensities of light, although it is fully capable of growing in very bright light. This is suggested by PAL, who cites (*l. c.*, p. 54) that plants of *N. acuminata* grown in glass jars and placed at a well lighted window still suffered from lack of sufficient illumination, which was manifested by thin and lanky growth. It is also absent in those parts where there is plenty of sedimentation.

It is found both in the hills (Java, 260—300 m alt.) and in the lowlands. In India it is recorded by G. O. ALLEN as bearing gametangia from August to December (1928, p. 66), whereas PAL cites (*l. c.*, p. 51) from November to March. I found ripe oospores in plants of var. *Bélangeri* collected from May to November and in var. *subglomerata* from April to December. *Spirogyra* species are mentioned as algal epiphytes and were found in some specimens.

N. acuminata is seldom solitary in growth, being usually found together with *Nitella mucronata* and *Chara fibrosa* ssp. *gymnopitys*, and the Phanerogams *Najas, Scirpus, Marsilia, Eriocaulon truncatum, Xyris indica.*

Distribution[1]). Between 45° N. and 20° S.; ASIA, India, Malaysia, cf. varieties. Moreover in lit.: Japan, MIGULA (1930, p. 211) — AMERICA, N. Am.: Lake Ontario, T. F. ALLEN (1892, p. 8, *glom.*); United States, cf. varieties, for var. *glomerulifera*, cf. BRAUN & NORDSTEDT (1882, p. 40), NORDSTEDT (1889, pp. 7, 23), T. F. ALLEN (1892, p. 8); C. Am.: Mexico, Panama, Cuba, Porto Rico, Trinidad, Martinique, cf. varieties; S. Am.: Venezuela, BRAUN & NORDSTEDT (1882, p. 40, var. *glom.* and *Gollm.*), NORDSTEDT (1889, p. 7, *Gollm.*); Brazil, BRAUN & NORDSTEDT (1882, p. 35) — AFRICA, N. Afr.: Egyptian Sudan: Seriba Ghattas, BRAUN & NORDSTEDT (1882, p. 35); S. Afr.: S. Rhodesia, GROVES & STEPHENS (1926, p. 147); Madagascar, GROVES (1928, p. 127), ZANEVELD (1939, p. 381); Mauritius, BRAUN (1849, p. 293; 1868, p. 804), BRAUN & NORDSTEDT (1882, p. 35); Réunion, BRAUN (1868, p. 804, *mauritiana* ?).

var. *α* **Bélangeri** A. BRAUN in HOOKER's Journ. Bot. I, 1849, p. 292; WALLMAN in Act. Soc. Linn. Bordeaux 21, 1856, p. 30; BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, pp. 10, 38; T. F. ALLEN, Charac. Americ. 1, 1888, p. 43 (*nom. tant.*); H. & J. GROVES in Philipp. Journ. Sci. 7, 1912, p. 70 — *Nitella Belangeri* A. BRAUN in Monatsber. Kön. Akad. Wiss. Berlin, 1858, p. 355 (*nom. tant.*); id. in Monatsber. Kön. Akad. Wiss. Berlin f. 1867, p. 804, 1868 (*nom. tant.*) — *N. acuminata β N. subglomerata* A. Br. f. *brachyteles* A. BRAUN in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 37; T. F. ALLEN, Charac. America 2, 1892, p. 7 — *N. acuminata* A. Br. var. *indica* A. Br. f. *brachyteles* NORDSTEDT in Forsch. Reise S. M. S. "Gazelle", Bot. Th. 4, 1889, p. 6 — *N. acuminata* A. Br. var. *Lindheimeri* A. BRAUN in HOOKER's Journ. Bot. 1, 1849, p. 293 (*nom. tant.*); T. F. ALLEN, Charac. America 1, 1888, p. 43 (*nom. tant.*) — *N. acuminata ε N. Lindheimeri* A. BRAUN in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 38 — *N. Lindheimeri* A. BRAUN in Monatsber. Kön. Akad. Wiss. Berlin, 1858, p. 355 (*nom. tant.*); id. in Monatsber. Kön. Akad. Wiss. Berlin f. 1867, p. 805, 1868 (*nom. tant.*); T. F. ALLEN, Charac. America 2, 1892, p. 7 (as *N. Lindheimer*) — *Chara Belangeri* A. BRAUN in lit.

---

[1]) This cannot be given complete, as the various authors did not always cite the variety to which a specimen belongs.

Illustration. BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, pl. 1, f. 25.

Plants with very short dactyls, in the type specimen hardly visible with the naked eye, in other specimens up to as long as the diam. of the stem.

As I had the opportunity to study the type, I give some data thus far unpublished. *Stem* diam. up to 1 mm. *Sterile branchlets* 1—3 cm long, at the apex provided with 3—4 dactyls, c. 500 μ long. *Antheridia* c. 284 μ in diam. *Oogonia* 356—400 μ long (incl. coronula), 302—320 μ wide; *spiral-cells* showing 7—9 convolutions; *coronula* c. 80 μ high, c. 124 μ wide at base, individual cells strongly converging and persistent; *oospores* bright-brown, 267 μ long, 240 μ wide, with 6—7 broad ridges with very prominent flanges (about 8 μ); *outer membrane* coarsely granulate and diaphanous.

INDIA: Coromandelia, in pools near Gengu, 1826—'28, BÉLANGER s.n. (B) — *type*; Malabaria, Bombay, Concan, 1847, STOCKES s.n., herb. HOOKER in (B).

JAVA: Batavia, Ragoenan, Pasarminggoe, X 1930, Geneesk. Dienst v. Malaria Bestrijd. s.n. (Bz); Buitenzorg, Buitenzorg, in a rice-field along the road to Tjiboerial, 260 m alt., 9 V 1928, VAN STEENIS 1510 (Bz); Malang, Roemah Klampok, 300 m alt., 14 V 1936, J. H. ? 75 (Bz).

PHILIPPINE ISLANDS: Luzon, Prov. of Laguna, VI—VII 1915, MACGREGOR, Bur. of Sci. 27630 (K).

AMBOINA: Amboina, 11 VI 1875, B.N. (= NAUMANN) 364 (B), *type* of *N. acuminata* A. BR. var. *indica* A. BR. f. *brachyteles* NORDST.; ibid., same date, B. N. 367 (B).

Remarks. Variety *Bélangeri* is characterized by its very short dactyls though there are transitions to var. *subglomerata*.

There is some confusion about the orthography of the name of this variety. In the type description (1849, p. 292) BRAUN writes a double l but omits the accent, and cites the name of the collector, CH. BÉLANGER, likewise. However, in 1858 (p. 355) and in 1868 (pp. 804, 805) BRAUN himself writes "*Belangeri*". On the label of the type specimen BRAUN has written "*Nitella Bellangeri* A. BR. 1838", but one *l* is struck out. This is probably done by BRAUN himself in 1858 as there is on the same label a note in BRAUN's handwriting: "*Nitella* (*acuminata*) *Belangeri* 1858". It is therefore without any doubt that "*Bellangeri*" is an unintentional orthographic error and the variety must be written as *Bélangeri*.

Distribution [1]). Between 40° N. and 15° N.; ASIA, Coro-

[1]) Cf. note [1]) on p. 59.

mandelia, Malabaria. Moreover in lit.: AMERICA, United States: Missouri, BRAUN (1849, p. 293); Texas, BRAUN (1849, p. 293), BRAUN & NORDSTEDT (1882, p. 38).

var. *β* **subglomerata** A. BRAUN in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 36 (as *N. acuminata β N. subglomerata*); T. F. ALLEN, Charac. America 1, 1888, p. 41 (*nom. tant.*); NORDSTEDT in Hedwigia 27, 1888, pp. 181, 194; id. in Lunds Univers. Års-skr. 25, 1889, p. 7; H. & J. GROVES in Journ. Linn. Soc., Bot., 33, 1898, p. 325; id. in URBAN, Fl. Ind. Occ. 7, 1911, p. 33 — *Nitella subglomerata* A. BRAUN in Monatsber. Kön. Akad. Wiss. Berlin, 1858, p. 356; id. in Monatsber. Kön. Akad. Wiss. Berlin f. 1867, p. 805, 1868; T. F. ALLEN, Charac. America 2, 1892, pp. 2, 7 — *Nitella acuminata* A. BR. var. *indica* A. BRAUN in Abh. Kön. Akad. Wiss. Berlin, 1882, pp. 9, 38; T. F. ALLEN, Charac. America 1, 1888, p. 41 (*nom. tant.*); NORDSTEDT in Lunds Univers. Års-skr. 25, 1889a, p. 7; id. in Forschungsreise S. M. S. "Gazelle", 1889b, p. 6; DE WILDEMAN, Prodr. Fl. Alg. Ind. Néerl. 1897, p. 31; id., Suppl. et Tabl. Stat., 1899, p. 98; id., Alg. Fl. Buitenz., 1900, p. 374; H. & J. GROVES in Philipp. Journ. Sci. 7, 1912, p. 70; H. GROVES in Journ. Linn. Soc., Bot., 42, 1914, p. 213 — *Nitella acuminata* A. BR. var. *javanica* A. BRAUN in herb. Berol.; id. in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 49 (*nom. tant.*).

Illustrations. BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, pl. 1, figs. 22—24, 26; T. F. ALLEN, Charac. America 2, 1, 1892, unnumbered pl.

Dactyls of the *sterile branchlets* macroscopically visible, longer than 650 *μ*. Primary rays as long as to ¾ as long as the secondary rays (dactyls). *Dactyls* of the *fertile branchlets* very short.

MALAY PENINSULA: Straits Settlements, 8 VII 1896, BLOW 51 (K); Singapore, Tanglin Ditches, 1898, RIDLEY 9137 (K, Si).

SUMATRA: West Coast, near Padang, in the river, 13 IV 1888, WEBER 554 (L).

JAVA: Batavia, near Batavia, in swamps, 1855, HASSKARL s.n. (B), *type* of *N. acuminata* var. *indica*; ibid., Batavia, without collector's name (probably JUNGHUHN) and date, ex herb. VAN DEN BOSCH (B, L).

PHILIPPINE ISLANDS: Mindanao, near Sambang, in a ditch, VI 1861 (Prussian Exped. to East-Asia, 1860—'62), WICHURA 2005 (B).

AMBOINA: Amboina, near the coal-shed in a fresh water ditch, 11 VI 1875, NAUMANN 365 (B); ibid., same date, NAUMANN 366 (B); ibid., VI—XI 1913, ROBINSON 2404 (Bz, L).

Remarks. This variety is at once distinguished by the macroscopically dactyls.

I have cited var. *indica* as a synonym, as I cannot find any difference. Whilst BRAUN writes (1882, p. 37) that the type specimen bears no gametangia I found immature ones. The oogonia appear to be geminate and the antheridia solitary. Therefore, it appears incorrect that NORDSTEDT in his "Clavis" in the "Fragmente" (1882, p. 9) has separated var. *indica* from var. *subglomerata* on account of its solitary oogonia. The geminate oogonia were also present in the specimen in herb. VAN DEN BOSCH at Leiden. In the Berlin specimen, BRAUN could not state this with certainty. About the Mindanao specimen, BRAUN remarked already (1882, p. 37) that it has quite the same habit as *subglomerata*. Therefore, they are undoubtedly identic and the name *subglomerata* has date priority.

On the cover of the type specimen of var. *indica* BRAUN himself has written "*Nitella acuminata* var. *javanica* mihi"; this name is also cited on p. 49 of the "Fragmente", however, the variety has been published under the name *indica*.

Distribution[1]). Between 45° N. and 10° S.; ASIA, Malaysia: Malay Peninsula, Sumatra, Java, Philippine Islands, Amboina. Moreover in lit.: Borneo, GROVES (1914, p. 213) — AMERICA, N. Am.: United States: Oregon, New York, Illinois, T. F. ALLEN (1892, p. 7), NORDSTEDT (1889a, p. 7); Pennsylvania, BRAUN & NORDSTEDT (1882, p. 32), T. F. ALLEN (1892, p. 7); New Jersey, T. F. ALLEN (1892, p. 7); Missouri, St. Louis, Texas; C. Am.: Mexico, BRAUN & NORDSTEDT (1882, p. 37), T. F. ALLEN (1892, p. 7); Sauvies Islands, T. F. ALLEN (1892, p. 7); Panama, BRAUN (1858, p. 356), BRAUN & NORDSTEDT (1882, p. 36); Cuba, NORDSTEDT (1888, p. 181), GROVES (1911, p. 23); Porto Rico, Martinique, GROVES (1911, p. 23), Trinidad, GROVES (1898, p. 325; 1911, p. 33); S. Am.: Brazil, BRAUN & NORDSTEDT (1882, p. 36), NORDSTEDT (1889a, p. 7).

II. Subsectio HETERODACTYLAE A. BRAUN in Monatsber. Kön. Akad. Wiss. Berlin f. 1867, p. 807, 1868 (*nomen propositum*); GROVES & STEPHENS in Trans. Roy. Soc. S. Afr. 13, 1926, p. 145; J. GROVES in Journ. Bot. 73, 1935, p. 48; ZANEVELD in Blumea 3, 1939, p. 378 — Subsect. *Arthrodactyles* HY in Bull. Soc. bot. France 60, 1913, Mém. 26, p. 12, *pro parte* — Subsect. *Stenodactyles* HY in Bull. Soc. bot. France 60, 1913, Mém. 26, p. 16, *pro parte*.

Ultimate rays of the branchlets indifferently 1—2- or 1—3-celled.

---

[1]) Cf. footnote on p. 59.

3. **Nitella sumatrana** FILARSZKY in Arch. Hydrobiol. 1934, Suppl. Bd. 12, Trop. Binnengew., Bd. 4, pp. 709—711; id. in Math. u. Naturw. Anz. Ung. Akad. Wiss. 52, 1935, p. 468 (*nom. tant.*).

Illustrations. FILARSZKY, *l. c.* 1934, figs. 9—14; the pres. paper, figs. 4*a—f*.

Plant monoecious, rigid but fragile, up to 15 cm high (probably much higher). *Stem* slender, 375—450 μ in diam. *Internodes* half to twice the length of the branchlets. *Sterile branchlets* 7—8 in a whorl, 1—2 times furcate, 1—1.5 cm long, primary rays $^1/_3$—$^2/_3$ the length of the entire branchlet, secondary rays 4—6, tertiary rays (dactyls) 2—4, ± as long as the secondary ones (the lower whorls are all sterile). *Fertile branchlets* 5(—6) in a whorl, twice furcate, c. 0.5 cm long, primary rays $^3/_5$ as long as the entire branchlet, secondary rays 4—5, half as long as the tertiary rays, tertiary rays (dactyls) 3—4. The upper whorls are fertile, becoming more and more compact towards the apex of the plant (the "apikale Kurztrieben" of FILARSZKY, 1934, p. 709). One of these compact heads of fertile whorls is also present in the axils of the lower sterile whorls (FILARSZKY's "axiale Kurztrieben"). These compact fertile whorls are covered by a mucilagous cloud. *Dactyls* of the normal fertile rays longer than those of the sterile ones, occasionally one-celled but frequently two-celled, basal cell proportionally very long, viz. 70—80 μ, 3—4 μ wide with a swollen rounded end, flattened at the apex where the ultimate cell is inserted; ultimate cell short, allantoid, 4—5 μ long, 2—3 μ wide at base. The dactyls of the sterile whorls are much longer, up to 2 mm, two-celled, basal cell c. 700—1000 μ wide[1]). ♂ and ♀ *gametangia* sessile, together at the same nodes, except at the base of the primary rays. *Antheridia* solitary, terminal, c. 180—228 μ in diam. *Oogonia* solitary, lateral, 384—440 μ long (incl. coronula), 258—325 μ wide; *spiral-cells* showing 8—9 convolutions; *coronula* 44—56 μ high, 51—79 μ wide at base, evanescent, individual cells convergent, rounded at apex; *oospores* dark-brown, 263—335 μ long, 180—226 μ wide, with 6—7 ridges; *outer membrane* minutely granulate.

SUMATRA: Tapanoeli, Lake Toba, border of Samosir near Pangoeroeran (total depth 50—80 m), basin of Pangoeroeran from 1 m depth, 12 IV 1929,

[1]) FILARSZKY writes (p. 710) that the dactyls of the sterile and fertile whorls are often monarthrodactylous, however, this seems to be the case, as frequently the ultimate cell is dropped. The dactyls are badly represented in the figs. 9—14 of FILARSZKY.

German Limnol. Sunda Exped. TS 2a (Bu-Mus), *type*; ibid., S. border of the Porsea basin, at 3 m depth (total depth 450 m), 8 IV 1929, German Limnol. Sunda Exped. TP 1d (Bu-Mus).

Remarks. *Nitella sumatrana* is best characterized by the shape of the indifferently one- and two-celled dactyls. It comes very near to the monoecious *Heterodactylae*, viz. *N. abyssinica*, and *N. divaricata* from Africa, *N. inaequalis* from Madagascar, and *N. tuberculata* from Bengal. Now *N. divaricata* has the ultimate node of the branchlets sterile and the fertile whorls do not form condensed heads, *N. inaequalis* has the rays different in length and the ultimate cell of the two-celled dactyls is conspicuously contracted at the base, and, whilst both species have reticulate oospore membranes, in *N. tuberculata* the membrane is tuberculate. *N. abyssinica* differs in having the branchlets 3—4 times furcate.

Ecology. *N. sumatrana* is a rather slender plant, occurring in the upper layers of lakes with a great depth. The following particulars are still known from the second locality mentioned above, i.e. temp. of the surface 25°—27° C., alkalinity 1.56, conductivity $1.33 . 10^{-4}$, pH 8.3.

The species were infested with a great number of epiphytes, especially blue algae, viz. *Rivularia aquatica*. Between the dried material were fragments of *Chara australis* var. *Vieillardii* f. *simplicissima* and *C. zeylanica*.

Distribution. 3° N.; Asia, Malaysia: Sumatra.

4. Nitella tuberculata Kundu in Journ. Ind. Bot. Soc. 16, 1937, p. 223, figs. 1—12.

Plant monoecious, up to 15 cm high. *Internodes* somewhat exceeding the branchlets in length. *Sterile branchlets* 4—6 in a whorl, 2 cm long; secondary rays 4—5. *Fertile branchlets* usually 5, shorter than sterile ones; secondary rays 5—6; both kinds of branchlets 2—3 times furcate, not enveloped in mucus. *Dactyls* 2—3, occasionally one-celled, usually two-celled and rarely three-celled. ♂ and ♀ *gametangia* together at the second branchlet-node (lacking at the first node and at the base of the whorls), and also in lax heads, produced as an accessory shoot to the first branchlet-node. *Antheridia* solitary, 195—210 μ in diam. *Oogonia* solitary; *oospores* "light-yellow", 345 μ long, with 7—8 prominent ridges. *Membrane* tuberculate.

Fig. 1, *Nitella bipartita*; *a.* habit, nat. size; *b.* stem-node with fertile branchlet, × c. 20; *c.* decoration of oospore membrane, × c. 200 — Fig. 2, *Nitella moniliformis*, n. sp.; *a.* habit, nat. size; *b.* stem-node with fertile branchlet, × c. 27; *c.* decoration of oospore membrane, × c. 210 — Fig. 3, *Nitella Alleninda*, n. sp.; *a.* habit, nat. size; *b.* stem-node with fertile branchlet, × c. 20; *c.* sterile branchlet, × c. 7; *d.* decoration of oospore membrane, × c. 200; *e—h.* apices of dactyls, × c. 20.


1a
1b
1c
2a
2b
2c
3a
3b
3c
3d
3e
3f
3g
3h
MULDER ET MARKS DEL.

Remarks. Special features of this species are the partly one-, partly two-, and partly three-celled dactyls, and the tuberculate "NORDSTEDT-markings". No specimens examined.

Ecology. In a shallow ditch together with *Ceratophyllum* and *Najas* species.

Distribution. 25° N.; ASIA, India: Bengal.

III. Subsectio ARTHRODACTYLAE GROVES & BULLOCK WEBSTER, Brit. Charoph. 1, 1920, pp. 86, 110; J. GROVES in Journ. Linn. Soc., Bot., 46, 1924, p. 361; PRINTZ in ENGLER & PRANTL, Nat. Pfl. fam. 3, ed. 2, 1927, p. 426; G. O. ALLEN in Journ. Ind. Bot. Soc. 7, 1928, p. 51; PAL in Journ. Linn. Soc., Bot., 49, 1932, p. 64; J. GROVES in Journ. Bot. 73, 1935, p. 49; GROVES & ALLEN in Proc. Roy. Soc. Queensl. 46, 1935, p. 40; ZANEVELD in Blumea 3, 1939, p. 379 — Sect. *Pleonarthrae* VON LEONHARDI in Verh. naturf. Ver. Brünn 2, 1864, repr. p. 37.

Dactyls (ultimate rays of the branchlets) each consisting of two or more cells.

Key to the series.

1a.	Dactyls strictly two-celled	1. BICELLULATAE
b.	Dactyls more-celled	2
2a.	Dactyls indifferently 2—3-celled	2. HETEROCELLULATAE
b.	Dactyls indifferently 2—6-celled	3. PLURICELLULATAE

1. Series BICELLULATAE J. GROVES in Journ. Bot. 73, 1935, p. 49 (*nom. tant.*); GROVES & ALLEN in Proc. Roy. Soc. Queensl. 46, 1935, p. 40; ZANEVELD in Blumea 3, 1939, p. 379 — *Nitellae mucronatae* A. BRAUN in HOOKER's Journ. Bot. 1, 1849, p. 195, *pro parte* — Subsect. *Diarthrae* A. BRAUN ap. VON LEONHARDI in Lotos 13, 1863, repr. p. 11, *pro parte*; id. in Verh. naturf. Ver. Brünn 2, 1864, repr. p. 37; A. BRAUN, Consp. syst. Charac. europ., 1867, p. 2 — Sect. *Diarthrodactylae* A. BRAUN in Monatsber. Kön. Akad. Wiss. Berlin f. 1867, p. 797, 1868; id. in COHN, Krypt. Fl. Schles., 1876, p. 368; BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 10; T. F. ALLEN, Charac. America 1, 1888, p. 43; MIGULA, Die Charac., 1897, p. 97; H. & J. GROVES in URBAN, Symb. Antill. 7, 1911, p. 30; NORDSTEDT in Proc. Roy. Soc. Vict. 31, N. S., 1918, p. 2 — Subsect. *Stenodactyles* HY in Bull. Soc. bot. France 60, 1913, Mém. 26, p. 16, *pro parte*.

Dactyls (ultimate rays of the branchlets) strictly two-celled.

5. Nitella flagelliformis A. BRAUN in HOOKER's Journ. Bot. 1, 1849, p. 294; WALLMAN in Act. Soc. Linn. Bordeaux 21, 1856, p. 20; BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 47, pl. 5, figs. 115—117 — *Nitella flabelliformis* in herb. Berolinense — *Nitella dispersa* A. BRAUN in Abh. Kön. Akad. Wiss. Berlin, 1882, pp. 10, 47; id. in Monatsb. Kön. Akad. Wiss.

Berlin f. 1867, p. 797, 1868 (*nom. tant.*); T. F. ALLEN, Charac. America 1, 1888, p. 44 (*nom. tant.*); NORDSTEDT in Lunds Univers. Års-skr. 25, 1889, p. 8; J. GROVES in Journ. Linn. Soc., Bot., 46, 1924, pp. 361, 365; GROVES & ALLEN in Journ. Bot. 65, 1927, p. 336; G. O. ALLEN in Journ. Ind. Bot. Soc. 7, 1928, p. 53, pl. 2, f. 1, text-f. 4; MIGULA in Hedwigia 70, 1930, p. 212; MUKERJI in Proc. 19th Ind. Sci. Congr., Bangalore, 1932, p. 328; id. in Proc. 21th Ind. Sci. Congr., Bombay, 1934, p. 295; G. O. ALLEN in Journ. Ind. Bot. Soc. 15, 1936, p. 51; AGHARKAR & KUNDU in Journ. Dep. Sci., N.S., 1, 1937, pp. 3, 4, pl. 2.

Plant dioecious, dirty-green, flexible, transparent, 15—20 cm high. *Stem* rather slender, 384—600 μ in diam. Lower *internodes* as long as the branchlets, upper ones shorter. *Sterile branchlets* long, c. 2 cm, similar to the fertile branchlets. *Fertile branchlets* 5—7 in a whorl, not contracted into heads, up to 2 cm long, 4(—5) times furcate; primary rays half as long as the entire branchlet; secondary rays 5—6 of which 3—4 are again furcate into 3—5 tertiary rays, 2—3 of these latter again furcate into 3—4 quaternary rays, some of these sometimes again divided into 2—3 quinary rays; not enveloped in mucus. *Dactyls* of sterile and fertile branchlets similar, 2—4, unequal in length, uniformly two-celled, lower cell frequently long but varying in length, somewhat rounded at the apex, ultimate cell usually conical, but allantoid ones also occur; in the latter case the lower cell is also very much elongated. ♂ and ♀ *gametangia* sessile, solitary, in all the furcations of the branchlets. *Antheridia* 320—540 μ in diam. *Oogonia* 400—520 μ long (incl. coronula), 304—325 μ wide; *spiral-cells* showing 8—9 convolutions; *coronula* 45—58 μ high, c. 106 μ wide at base; *oospores* dark-brown, 302—350 μ long, 248—280 μ wide, with 6—8 prominent, sharp flanged ridges; *outer membrane* imperfectly reticulate.

INDIA: "India orientalis", without exact locality, date and collector's name, ex herb. DESFONTAINES in (B), *type*; Malabaria, Prov. of Bejapur, Concan, 1847, STOCKES s.n. (B); Assam, without exact locality, date and collector's name, ex herb. HOOKER in (B).

Remarks. A fairly uncommon species, up to 1930 only known from India, but in that year also recorded from Japan. *Nitella flagelliformis* is closely allied to *N. dualis*, *N. globulifera* and *N. Annandalei*, three other dioecious macrodactylous species with uniformly two-celled dactyls. The latter two species are insufficiently known (oospores!). *N. flagelliformis* differs from these two species in having more furcate branchlets, whereas *N. dualis* is glococephalous. The other species belonging to this group are hitherto only recorded from Australia.

A little note about the nomenclature of this species may be made. This species was first published by BRAUN in 1849 under the name of *N. flagelliformis*. Afterwards BRAUN detected between the type specimens fragments of another *Nitella* which was published by him in 1882 (p. 54) as *N. pseudoflabellata*. In BRAUN's opinion it was therefore not justified to maintain the name of *N. flagelliformis* and he renamed the species as *N. dispersa*. (1882, p. 47). This is, of course, in contradiction to the now adopted Nomenclatural Rules, reason why the name *dispersa* has to be rejected and that of *flagelliformis* re-established.

Ecology. *Nitella flagelliformis* is found growing in dense tufts in shallow water with a soft muddy bottom of large pools and ponds. It is found in India in the rainy season and in the early to middle cold season. In the habitats

mentioned it grows together with *Nitella acuminata* var. *Bélangeri*, *N. furcata*, *Chara Braunii*, *C. corallina*, *C. brachypus* and *C. zeylanica*.

In Kashmir MUKERJI found it together with *Nitella acuminata*, *N. hyalina* and *Nitellopsis obtusa* to a depth of 7.50 m.

Distribution. Between 35° N. and 17° N.; ASIA, India: Malabaria and Assam. Moreover in lit.: Japan: MIGULA (1930, p. 212); India: W. Himalaya, MUKERJI (1932, p. 328; 1934, p. 295); Gangetic Plain, GROVES & ALLEN (1927, p. 336); ALLEN (1928, p. 63; 1936, p. 51).

6. Nitella dualis NORDSTEDT in Forschungsr. S.M.S. "Gazelle", 4. Th. Bot., 1889, p. 7, pl. 1, figs. 1—9; T. F. ALLEN, Charac. America 1, 1888, p. 48 (*nom. tant.*); NORDSTEDT in Act. Univers. Lund. 25, 1889, p. 13; J. GROVES in Philipp. Journ. Sci. 19, 1921, p. 663.

Plant dioecious, slender, elongate. *Internodes* of the sterile branchlets 2—4 times, those of the fertile branchlets 1—2 times the length of the branchlets. *Sterile branchlets* 6 in a whorl, 1—1.5 mm long, 3—4 times furcate; secondary rays 5—7. *Fertile branchlets* 6 in a whorl, up to 1 cm long, 2—3 times furcate; secondary rays 5—7; contracted into heads enveloped in mucus. *Dactyls* 3—4, uniformly two-celled. ♂ and ♀ *gametangia* together at all free branchlet-nodes, not at the base of the whorls, solitary. *Antheridia* c. 200 μ in diam. *Oospores* chestnut-brown, 180—260 μ long. *Membrane* reticulate, the meshes c. 5 μ in diam.

Remarks. Nearly allied to *N. flagelliformis*, but differing by the larger oogonia and the fertile heads enveloped in mucus. The ultimate dactylous cell is allantoid, which gives the plant at first sight an external resemblance with a polyarthrodactylous species. In this group indeed the species was placed by T. F. ALLEN (1888, p. 48), but this, I presume, is not correct, as the dactyls are distinctly two-celled. No specimens examined.

Ecology. Unknown.

Distribution. Between 12°30′ N. and 6°20′ N.; ASIA, Indo China — AFRICA, Liberia.

7. Nitella globulifera PAL in Journ. Linn. Soc., Bot., 49, 1932, pp. 64, 69, pl. 9; id. in Journ. Burma Res. Soc. 18, 1929, p. 113 (*nom. tant.*).

Plant dioecious, very small. *Internodes* 2—4 times the length of the branchlets. *Sterile* and *fertile branchlets* ± similar, once or twice furcate; secondary rays 6—8. Fertile branchlets in heads enveloped in dense mucus. *Dactyls* 4—6, two-celled. ♂ and ♀ *gametangia* together at both branchlet-nodes, solitary. *Antheridia* 370 μ in diam. *Oogonia* 350 μ long (incl. coronula), showing 9—10 convolutions of the spiral-cells. *Oospores* not described.

Remarks. Different from *Nitella Annandalei* and *N. dispersa* by its less furcate branchlets. Otherwise characterized by the length of the penultimate rays, which are longer than the dactyls. No specimens examined.

Ecology. In a swift running stream, together with *Chara nuda*.

Distribution. 22° N.; ASIA, India: Burma.

8. Nitella Annandalei PAL in Journ. Linn. Soc., Bot., 49, 1932, pp. 64, 70, pl. 10; J. GROVES in Journ. Linn. Soc., Bot., 46, 1924, pp. 361, 365 (as *N.* sp. nov. ?).

Plant dioecious, rather stout. *Internodes* 2—5 times the length of the branchlets. *Sterile* and *fertile branchlets* ± similar, 8 in a whorl, 2—3 times

furcate; secondary rays 6—8. Fertile whorls enveloped in mucus. *Dactyls* usually 6, two-celled, ultimate cell very narrow and acute. *Antheridia* at all free branchlet-nodes, solitary, 375—450 μ in diam. Female plant unknown.

Remarks. Nearly allied to *Nitella globulifera*, but antheridia larger, dactyls longer than the penultimate rays, and the branchlets more furcate. No specimens examined.

Ecology. In a river.

Distribution. 20° N.; ASIA, India: Burma.

9. **Nitella axillaris** A. BRAUN in Monatsb. Kön. Akad. Wiss. Berlin, 1858, p. 356; BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, pp. 11, 48; T. F. ALLEN, Charac. Americ. 1, 1888, p. 44 (*nom. tant.*); NORDSTEDT in Hedwigia 70, 1888, pp. 182, 194; id. in Act. Univers. Lund. 25, 1889, p. 9; T. F. ALLEN, Charac. Americ. 2, 2, 1894, pp. 9, 15; id. in Bull. Torrey Bot. Cl. 25, 1898, p. 73 (*nom. tant.*); H. & J. GROVES in URBAN, Symb. Antill. 7, 1911, pp. 30, 34; GROVES & ALLEN in Journ. Bot. 65, 1927, p. 336; G. O. ALLEN in Journ. Ind. Bot. Soc. 7, 1928, p. 55 — *Nitella axillaris* A. Br. var. *javanica* A. BRAUN in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 49; DE WILDEMAN, Fl. Alg. Ind. Néerl., 1897, p. 31; id., Suppl. et Tabl. Stat., 1899, p. 98; id., Alg. Fl. Buitenz., 1900, p. 375.

Illustrations. BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, pl. 1, figs. 35—38 and pl. 5, figs. 118—122 (var. *javanica*); T. F. ALLEN, Charac. Americ. 2, 2, 1894, unnumbered plate; DE WILDEMAN, Alg. Fl. Buitenz., 1900, f. 139; G. O. ALLEN in Journ. Ind. Bot. Soc. 7, 1928, pl. 3.

Plant monoecious, transparent, shining, in dried specimens brown by the covering with clay, in living state, however, probably bright-green, 25—45 cm high. *Stem* stout, 800—1100 μ in diam. *Internodes* 1½—4 times the length of the branchlets. *Sterile branchlets* (4—)6 in a whorl, c. 2 cm long, once furcate, primary rays nearly as long as the entire branchlets, secondary rays (2—)3(—4), two-celled, much abbreviated, basal cell c. 75 μ long, c. 50 μ wide, ultimate cell c. 75 μ long, c. 30 μ wide, conical acuminate. *Fertile branchlets* contracted into dense heads of c. 3 cm diam., of which 1—5 are produced in the axils of the whorls of sterile branchlets only, sessile, branchlets 4—6 in a whorl, usually 1—2 times furcate, primary rays c. 375 μ long, secondary rays 1—3, c. 225 μ long, tertiary rays, if any, (1—)3(—4), two-celled, basal cell c. 270 μ long, c. 80 μ wide, ultimate cell c. 75 μ long, c. 30 μ wide, destitute of mucous envelopment. *Dactyls* (1—)3(—4), two-celled; basal dactylous cell of the sterile branchlets tapering into the conical and strongly acuminate ultimate cell; basal

dactylous cell of the fertile branchlets rounded at the apex, therefore proportionally being much wider than the more allantoid ultimate cell. The length and the diam. of the inferior cell of the dactyls is much larger in the fertile branchlets than in the sterile ones. ♂ and ♀ *gametangia* sessile, together at all free nodes, frequently lacking at the ultimate one. *Antheridia* solitary, terminal, earlier ripe than oogonia, 220—270 μ in diam. *Oogonia* solitary or geminate, seldom triple, lateral, in not fully mature specimens 330—370 μ long, c. 300 μ wide; *spiral-cells* showing 7 convolutions; *coronula* 45 μ high, 30 μ wide at base, persistent; *oospore* (only one seen in the Java specimen) bright-brown, 270 (290—320) μ long, 255 (250—300) μ wide, with 6 broad ridges; *outer membrane* transparent, reticulate.

JAVA: Batavia, Batavia, III, no year, no collector's name (JUNGHUHN?), ex. herb. VAN DEN BOSCH in (B, L), *type* of *N. axillaris* var. *javanica* in (L).

Remarks. The features of *N. axillaris* are the fertile heads being always axillary produced and never terminal, and the length of the oospore varying between 270 and 320 μ. These characters alone seemed to BRAUN important enough to separate this species from *N. translucens*[1]) and *N. brachyteles*, both recorded from Europe and Africa, which come very near to it also in other respects. Two other species which are hardly different from these species have been described by T. F. ALLEN, viz. *N. Morongii* (1887, p. 214) from Nantucket (N. Americ.) and *N. sublucens* (1895, p. 70) from Japan. However, the last four species have the fertile heads not only axillary placed but also terminally. Having studied a great number of specimens. I felt inclined to include these four species, as well as *N. axillaris*, as varieties into one single species, for which the name *translucens* would be the valid one. However, a final decision in this matter has to be postponed until the type specimens have been checked.

I have dropped var. *javanica*. The habit of the variety should be a little more delicate and the oospores a little smaller. The type and the specimens extant in (B) and (L), however, do not show any essential difference in the size of the ripe oospores, and as the habit is also fairly robust (the stem-diam. is 1000 μ) I consider them identic.

With the naked eye *N. axillaris* seems very much like *N. acuminata*, with which it is frequently growing together, but it is microscopically at once distinghuished by its two-celled dactyls.

[1]) Cf. also MIGULA (1897, p. 44), who states, in contradistinction to other authors, that the oospores of *N. translucens* are 260—290 μ long and 240—270 μ wide, thus having the same dimensions as *N. axillaris*.

Ecology. This robust, transparent and in a dried state shining plant occurs in ponds and stagnant pools, usually together with dense masses of *N. acuminata*. In India it is only collected in the rainy season.

Distribution. Between 30° N. and 70° S.; ASIA, Malaysia: Java. Moreover in lit.: India: Gangetic Plain, GROVES & ALLEN (1927, p. 336); ALLEN (1928, p. 55) — AMERICA, C. Am.: Mexico, BRAUN & NORDSTEDT (1882, p. 48), Guatemala, NORDSTEDT (1888, p. 182); Cuba, NORDSTEDT (1888, p. 182), GROVES (1911, p. 34); Porto Rico, NORDSTEDT (1888, p. 194), GROVES (1911, p. 34); NORDSTEDT (1889, p. 9); S. Am.: Venezuela, BRAUN (1858, p. 356), NORDSTEDT (1889, p. 9).

10. Nitella bipartita FILARSZKY in Arch. f. Hydrobiol. 1934, Suppl. Bd. 12, Trop. Binnengew. Bd. 4, p. 706; id. in Math. u. Naturw. Anz. Ungar. Akad. Wiss. 52, 1935, p. 468 (*nom. tant.*).

Illustrations. FILARSZKY, *l. c.* 1934, figs. 1—2; the pres. paper, figs. 1*a*—*c*.

Plant monoecious, thin, flexible, 4—6 cm high, densely overgrown with epiphytes. *Stem* slender, 450—675 μ in diam. *Internodes* in the lower parts of the plants 1—1½ times the length of the branchlets; in the upper parts 2—5 times. *Sterile branchlets* 5—6 in a whorl, constantly twice furcate, up to 2 cm long; primary rays usually half as long as the entire branchlet, in the lower parts still more; secondary rays 3—4; tertiary rays (dactyls) 2—3. *Fertile branchlets* (5—)6(—7) in a whorl, up to 0.5 cm long, contracted into heads, constantly two times furcate, not enveloped in mucus; primary rays c. 0.5 cm long; secondary rays 3—5; tertiary rays (dactyls) 2—4. *Dactyls* 2—4, very uniform in length, constantly two-celled, basal cell large, c. 1200 μ long, c. 180 μ wide, cylindrical, rounded at apex; ultimate cell conical, sometimes a little incurved, c. 105 μ long, c. 60 μ wide at base. ♂ and ♀ *gametangia* together at all and the same free branchlet-nodes, sessile. *Antheridia* solitary, terminal, earlier ripe than the oogonia, therefore usually only visible at the young nodes, c. 270 μ in diam. *Oogonia* solitary, not surrounded by a mucous cloud, lateral, 462—534 μ long (incl. coronula), 312—356 μ wide; *spiral-cells* showing 6—7 convolutions; *coronula* c. 89 μ high, 105—134 μ wide at base, cell-series of the upper row somewhat shorter than those of the lower row; *oospores* black, c. 213 μ long, c. 267 μ wide, with 5—6 indistinct ridges; *outer membrane* provided with scattered tubercles on a granulate background.

SUMATRA: Palembang, Ranau, rice-field at the border of Lake Ranau, 560 m alt., 6 II 1929, German. Limnol. Sunda Exped. RSa,? (Bu-Mus), *type*.

JAVA: Buitenzorg, Buitenzorg, in rice-fields near the Tjisadani, 1929, VAN STEENIS s.n. (Bz).

Remarks. *Nitella bipartita* is at once recognizable by its uniformously two-furcate branchlets. FILARSZKY states (1934, p. 706) that it has the habit of *N. Leibergii*, but as the type consists of some small fragments only this cannot be ascertained. FILARSZKY writes (*l. c.* p. 706): "Trocken- u. Formol-Material", but here a mistake must have been made. The dried specimens, preserved in two separate covers, both labelled by Dr FILARSZKY himself "*N. bipartita* F." unmistakebly belong to *Chara hydropitys* var. *indica*. The formalin material, on the other hand, is not dated 27 I 1929 as is published, but 6 II 1929, and is mixed up with *N. acuminata*. On account of these facts there remain but very small fragments from the type proper.

Another inconsistency is found in the description, in which FILARSZKY says: "Die fertilen Strahlen bilden reine Köpfchen (*Diffusae*)". The condition of the fertile whorls being contracted has to be named "*Congestae*". The few branchlet-whorls extant in the formalin material are not much contracted and this is the case too in FILARSZKY's little accurate fig. 1.

From Buitenzorg I borrowed a specimen, collected by VAN STEENIS, which in the lower parts is quite identic with the fragments of the type and in the upper parts shows a remarkable similarity in habit to pl. 71 of *N. muthnatae* described by T. F. ALLEN from the Fiji Islands (1887, p. 211). The branchlets of this plant are in the upper parts contracted into dense rounded heads, whereas in the lower parts they are diffuse. I think that in the type of *bipartita* only the lower branchlets are preserved and therefore I have given above an emendation of the description of that species on account of the Buitenzorg plant. *N. muthnatae* differs from *N. bipartita* in characters of minor importance, i. e. smaller gametangia, which are only developed at the ultimate free node. As I did not see the type of *N. muthnatae* I cannot decide to the identity of both species. *N. Leibergii* has once and twice furcate branchlets and smaller oogonia. Characteristics for *N. bipartita* are the long axillary branchlets with dense clusters of fertile whorls and the NORDSTEDT-markings.

Ecology. *N. bipartita* is a small graceful plant, frequently densely covered with clay and epiphytic green algae. It grows in clusters in rice-fields, mixed up with *N. acuminata*.

Distribution. Between 5° N. and 7° S.; ASIA, Malaysia: Sumatra, Java.

11. Nitella pseudoflabellata A. BRAUN apud NORDSTEDT in Act. Univ. Lund. 16, 1880, p. 6; id. in VON MARTENS, Die Preuss. Exped. n. O.-Asien, Bot. Th., 1866, p. 143 (*nom. tant.*) — *Nitella mucosa*; *Nitella pseudoflabellata* f. *australiana*, f. *mucosa*, var. *imperialis*, var. *ramuscula*, var. *ramuscula* f. *testa-glabra*; cf. varieties.

Plant monoecious, elongated, 20—30 cm high, dark-green, sometimes brown by covering with clay. *Stem* slender to moderately stout, 385—700 μ in diam. *Internodes* 1—3 times the length of the branchlets. *Sterile branchlets* 6—8 in a whorl, frequently only forming the lower whorls, somewhat more rigid and divergent than the fertile branchlets, (2—)3(—4) times furcate, c. 2.5 cm long, primary rays $^1/_2$—$^2/_3$ the length of the entire branchlet, secondary rays (4—)5(—7), tertiary rays 5—6, sometimes some of them divided into 4—6 quaternary rays, very rarely 2—3 quinary rays occur. *Fertile branchlets* 5—7 in a whorl, 1.2—1.7 cm long, in the lower and older whorls similar to the sterile ones, in the younger upper whorls more compact, forming loose heads, 3(—4) times furcate, primary rays up to 1 cm long; secondary rays 5—7 which are usually all again furcate into (4—)5(—6) tertiary rays, of which sometimes some give rise to 4 quaternary rays, exceeding the tertiary rays in length; young fertile whorls enveloped in mucus or mucus not present at all. *Dactyls* 4—5, of equal length, very uniform, two-celled, basal cell very large, 500—800 μ long, 95—120 μ wide, cylindrical with a rounded distal end, ultimate cell usually conical, sometimes awl-shaped, 40—80 μ long, 30—40 μ wide at base. ♂ and ♀ *gametangia* at the same free nodes, but, since the antheridia are earlier ripe, the oogonia are frequently seen alone; usually lacking at the first node. *Antheridia* solitary, strictly terminal on a basal node-cell, sometimes hardly visible, sometimes 60 μ high, 200—300 μ in diam. *Oogonia* solitary, on a basal node-cell, which is less high than the antheridial one, viz. c. 45 μ, 375—465 μ long (incl. coronula), 320—355 μ wide; *spiral-cells* showing 7—8 convolutions; *coronula* small, 30—55 μ high, 45—60 μ wide at base, individual cells convergent, persistent; *oospores* golden to dark chestnut-brown, 290—350 μ long, 235—270 μ wide, with 6—7 ridges; *outer membrane* thin, light-brown, translucent, tuberculate with little, more or less closely set warts, on a dotted or granulate background, or being somewhat spongy.

Remarks. *Nitella pseudoflabellata* very much resembles *N. mucronata*, but there are some characters by which it can be recognized at once: 1. the dactyls are always two-celled and of equal length; 2. the number of rays at the second and ultimate furcations is 4 or

more; 3. the primary ray is elongated and as long as, or longer than half the length of the entire branchlet; 4. the dactyls are always longer than the secondary and tertiary rays.

AGHARKAR & KUNDU (1937, p. 7) regard the absence of gametangia in the first furcations of the branchlets as another characteristic for *N. pseudoflabellata*. In the type, however, I noticed gametangia at the first furcation.

As is pointed out under *N. flagelliformis* that species and *N. pseudoflabellata* were formerly confounded (cf. BRAUN & NORDSTEDT, 1882, p. 54). Some specimens, which unmistakebly belong to *N. pseudoflabellata* being monoecious, may therefore bear on the label the name of *flagelliformis* written by BRAUN,

It may not be superfluous, I think, to give a review of the history of *N. pseudoflabellata*. The name *pseudoflabellata* was published by BRAUN in 1866 (p. 143) concerning a plant collected near Loemar in W. Borneo; a description, however, was only published in the "Fragmente" of 1882 (p. 54). Here, BRAUN mentions gymnocephalous plants from four localities and moreover the Loemar plant as belonging to a newly created variety *mutila*.

In the meantime NORDSTEDT described two plants from New Zealand (1880, p. 16) which he named *N. pseudoflabellata* forma *mucosa* on account of the fertile whorls being enveloped in mucus. According to the International Botanical Rules one of these plants is now the type of *N. pseudoflabellata* and not the gymnocephalous plant from Loemar.

In an article on the *Charophyta* of Ceylon, GROVES (1922, p. 100), gave NORDSTEDT's form *mucosa* specific rank under the name of *N. mucosa*, though it is obvious from the above cited notes that this name is invalid.

In completing this review I must still add, that NORDSTEDT distinguishes in 1889 (p. 24) a new form, *australiana*, on account of a deviating decoration of the oospore membrane, and T. F. ALLEN (1898, p. 77) distinguished two more new varieties both occurring in Japan, one with the fertile heads enveloped in mucus, i. e. *imperialis* and one without such a mucous cloud, i. e. *ramuscula*.

Surveying the whole it is in full agreement with the International Botanical Rules that the plants with the fertile whorls enveloped in mucus must bear the name *pseudoflabellata*, if they are to be considered a separate species at all. However, I cannot share this opinion as the specific importance of the features: mucus or no mucus, is a too insignificant one, and that of the decoration of the oospore mem-

brane likewise. I therefore unite the gloeocephalous plants into the variety *mucosa*, and the gymnocephalous ones into another variety, for which the name *mutila* is the correct one, as there is no essential difference between the plant from Loemar and the other specimens cited in the "Fragmente" (cf. below under the var. *mutila*).

Ecology. Cf. under the varieties.

Distribution. Between 35° N. and 44° S., occurring in Japan, China, India (incl. Ceylon), Indo-China, Malaysia, various parts of Australia, New Caledonia and New Zealand.

var. α **mucosa** (NORDSTEDT) BAILEY, Compreh. Cat. Queensl. Pl., 1909, p. 678 [1]) — *Nitella pseudoflabellata* A. BR. f. *mucosa* NORDSTEDT in Act. Univ. Lund. 16, 1880, p. 16; BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, pp. 12, 56; T. F. ALLEN, Charac. America 1, 1888, p. 46 (*nom. tant.*); NORDSTEDT in Act. Univ. Lund. 25, 1889, pp. 10, 11, 25; id. in Proc. Roy. Soc. Vict., N. S., 31, 1918, p. 3 (*nom. tant.*) — *Nitella pseudoflabellata* A. BR. ex RIDLEY in Journ. Straits Branch R. A. Soc. 80, 1919, p. 163 — *Nitella mucosa* (NORDSTEDT) J. GROVES in Journ. Linn. Soc., Bot., 46, 1922, p. 100; J. GROVES in Journ. Linn. Soc., Bot., 46, 1924, pp. 361, 366; GROVES & ALLEN in Proc. Roy. Soc. Queensl. 46, 1935, pp. 41, 44. — ? *Nitella pseudoflabellata* A. BR. var. *imperialis* T. F. ALLEN in Bull. Torr. Bot. Cl. 25, 1898, p. 78.

Illustrations. NORDSTEDT in Act. Univ. Lund. 25, 1889, f. 12; T. F. ALLEN, Contrib. to Japan. Charac. 1898, unnumbered pl. (var. *imperialis*); the pres. paper, f. 7*a*.

Plants having the fertile whorls enveloped in mucus. *Outer membrane* tuberculate with small closely set warts of c. 2 μ height, in more or less distinct rows which are perpendicular to the ridges; if seen from above and at low magnifications it looks granulate.

MALAY PENINSULA: Malacca, Kuala Lumpur, in a pond, 23 II 1919, BURKILL, St. of Selangor 4427 (Si); ibid., Galang, in ditches, 1899, RIDLEY 10827 (K, Si); Singapore, Singapore, Cluny lake, I 1923, HOLTTUM s.n. (no 10016?) (Si); ibid., Gardens lake, VI 1937, PESTAVA s.n. (L).

SUMATRA: Atjeh & Depend., Perapat, in a quiet bight of Lake Toba, rooting at a depth of c. 2 m, 906 m alt., 27 V 1923, LÖRZING 10115 (Bz).

JAVA: Pekalongan, Tegalpandjang, G. Djaja, 2041 m alt., in a puddle, 18 V 1931, VAN STEENIS 4962b (Bz); Priangan, G. Papandajan, V 1931, VAN STEENIS 4962a (Bz).

Remarks. Both characteristics of this variety are more or less dubious: the presence of mucus can only be stated with certainty

[1]) BAILEY writes "*muscosa*" instead of *mucosa*.

in young, fresh plants or when they are preserved in fluid, and the opinions concerning the decoration of the membrane differ more or less. NORDSTEDT writes (1889, p. 10) that the membrane is closely set with prickles of 2—6 μ length and refers to the membrane of *N. capitata* where the warts are hyaline and only visible from the side. When seen from above the membrane of var. *mucosa* seems to be granulate. Now GROVES described in his Ceylon plants (1922, p. 100) the outer coloured membrane as granulate. According to GROVES & ALLEN (1935, p. 45) the membrane was drawn by BULLOCK WEBSTER, who depicts the type as tuberculate with a tendency to form lines.

The gloeocephalous var. *imperialis* of T. F. ALLEN (1898, p. 78) has the membrane covered with a close felt of fine hairs.

In agreement with the foregoing, the opinions differ about the membrane of var. *mutila*. NORDSTEDT (1889, p. 10) quoted the membrane as somewhat spongy, but in the same publication (p. 24) this author distinguishes a form *australiana* having a somewhat spongy membrane, but closely set with little prickles of c. 1.5—3 μ length. G. O. ALLEN (1937, p. 155) remarks about the spongy membrane that this is no doubt a case of felting which obscures the true decoration. GROVES in his study on the Ceylon plants (1922, p. 99) describes the membrane as imperfectly reticulate with about 6 large meshes between the ridges. In GROVES & ALLEN (1935, p. 45) the membrane is cited as being granulate. T. F. ALLEN distinguishes in his gymnocephalous var. *ramuscula* (1898, p. 79) two forms, one with the membrane marked by faint granules in very low relief, the tops of the ridges being dotted with more prominent granules irregularly disposed, almost as if toothed, and another form distinguished as f. *testa-glabra* with the coloured membrane perfectly smooth.

In this connection I studied the "NORDSTEDT-markings" of the two varieties, and I must state that in both varieties a granulate membrane may occur. Fig. 7*e* of this paper shows the membrane of the Java specimen of herb. VAN DEN BOSCH, but it is not different from those of the specimens of Malay Peninsula, RIDLEY 10827 and HOLTTUM 10016?, which belong to var. *mucosa*. The type specimen of var. *mutila* (Loemar) is represented by figs. 7*b* and *c*, which show small, more or less scattered tubercles of c. 1 μ height on a granulate or dotted background. In the specimens from Amboina and Chittagong (Bengal) the tubercles have the shape of press-buttons (cf. f. 7*d*).

As the type of var. *mucosa* was not at my disposal, I studied the specimens from Malay Peninsula determined by GROVES as *N. mucosa*.

As already stated these specimens have a granulate membrane. Fig. 7*a* depicts the outer membrane of the Java specimen collected by VAN STEENIS (4962a), it shows closely set warts of c. 2 μ length which are perpendicular to the ridges.

Ecology. In lakes, creeks and pools, immediately below the surface of the water. Ripe oospores are found from January to May.

Distribution. Between 45° N. and 44° S.; ASIA, Malaysia: Malay Peninsula, Sumatra, Java. Moreover in lit.: ? Japan, T. F. ALLEN (1898, p. 78); Ceylon, GROVES (1922, p. 100) — AUSTRALIA, Queensland, BAILEY (1909, p. 678), GROVES & ALLEN (1937, p. 44); Victoria, NORDSTEDT (1918, p. 3); New Zealand, NORDSTEDT (1880, p. 16; 1889, p. 25).

var. β **mutila** A. BRAUN in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 56 — *Nitella pseudoflabellata* A. Br. ap. NORDSTEDT in Act. Univ. Lund. 16, 1880, p. 6; BRAUN in VON MARTENS, Die Preuss. Exped. n. O.-Asien, Bot. Th., 1866, p. 143 (*nom. tant.*); id. in Abh. Kön. Akad. Wiss. Berlin, 1882, pp. 12, 54; T. F. ALLEN, Charac. America 1, 1888, p. 45 (*nom. tant.*); NORDSTEDT in Act. Univ. Lund. 25, 1889, p. 10; DE WILDEMAN, Prodr. Fl. Alg. Ind. Néerl., 1897, p. 31; id., Suppl. e. Tabl. Stat., 1898, p. 98; T. F. ALLEN in Bull. Torr. Bot. Cl. 25, 1898, p. 77; DE WILDEMAN, Alg. Fl. Buitenz., 1900, p. 377; NORDSTEDT in Proc. Roy. Soc. Victoria, N. S., 31, 1918, p. 3 (*nom. tant.*); J. GROVES in Journ. Linn. Soc., Bot., 46, 1922, p. 98; id., id., 1924, pp. 361, 366; MIGULA in Hedwigia 70, 1930, p. 212; FILARSZKY in Arch. Hydrobiol., 1934, Suppl. Bd. 12, Trop. Binnengew., Bd. 4, p. 713; GROVES & ALLEN in Proc. Roy. Soc. Queensl., 46, 1935, pp. 41, 44; AGHARKAR & KUNDU in Journ. Dep. Sci., N. S. 1, 1937, pp. 3, 6 — ? *Nitella pseudoflabellata* A. Br. ap. NORDSTEDT f. *australiana* NORDSTEDT in Act. Univ. Lund. 25, 1889, p. 24 — ? *Nitella pseudoflabellata* A. Br. ap. NORDST. var. *ramuscula* T. F. ALLEN in Bull. Torr. Bot. Cl. 25, 1898, p. 78 — *Nitella pseudoflabellata* A. Br. ap. NORDST. var. *ramuscula* T. F. ALLEN f. *testa-glabra* T. F. ALLEN in Bull. Torr. Bot. Cl. 25, 1898, p. 79 — *Nitella* sp. nov.? G. VON MARTENS in Proc. Asiat. Soc. Bengal, 1870, p. 183.

Illustrations. T. F. ALLEN, Contrib. to Japan. Charac., 1898, two unnumbered pl. (var. *ramuscula*); AGHARKAR & KUNDU in Journ. Dep. Sci., N. S., 1, 1937, pl. 3, figs. 1—5; the pres. paper, figs. 7*b*—*e*.

Plants having the fertile whorls not surrounded by mucus. *Oospore membrane* showing scattered tubercles of c. 1 μ height on a dotted or granulate background.

INDIA: Ceylon, Taprobane, along the road between Kadenama and Kandyducentem, 24 I 1862, Prussian Exped. to E.-Asia, WICHURA 2700 (B); E.-Bengal, Chittagong, no date, HOOKER & THOMSON s.n. (B).

INDO-CHINA: Tonkin, rapid in the river between Loch-Ouan and Ououbi, 2 XI 1885, BALANSA 17 (K).

MALAY PENINSULA: Pahang, Telok Sisik, Kuantan, in a pool of brown peaty water, 4 XII 1924, BURKILL, Singapore field no 17347 (Si).

SUMATRA: Tapanoeli, in rice-fields in the vicinity of Lake Toba, 1100 m alt., XII, no year and collector's name (probably JUNGHUHN) (L); ibid., in a large pool on the moor of Hoetagindjang, south of Lake Toba, 1500 m alt., 3 IV 1929, German Limnol. Sunda Exped. TH 1 and TH 13 (Bu-Mus), badly preserved, therefore identification not certain.

JAVA: Batavia, Batavia, no date, JUNGHUHN s.n. (B); id., near Batavia and Anjol, at the border of a swamp, III, no year, JUNGHUHN s.n. (L); Pasarminggoe, X 1930, Geneesk. Dienst v. Malaria Bestrijd. s.n. (Bz); Priangan, in a ditch along the road to G. Megamendoeng, 1350 m alt., no date, KURZ 123 (B, K); ibid., W.-Priangan, Sitoe Goenoeng, c. 1000 m alt., in the lake, 19 XI 1933, VAN STEENIS 5683 (Bz); ibid., Telaga Patengan, in the lake, no date, JUNGHUHN s.n., herb. VAN DEN BOSCH (B, L).

BORNEO: W. Division, Loemar, between Montrado and Sambas, 30 III 1863, E. VON MARTENS s.n. (B), *type* of *N. pseudoflabellata* var. *mutila*.

AMBOINA: Amboina, in the lake of the Government's garden, 1828, ZIPPELIUS s.n. (L), mixed with *Chara corallina*.

NEW GUINEA: Papua, at base of the Rouna falls, in a pool on exposed rock under continual spray, 270 m. alt., 27 V 1935, CARR 12380 (B, L).

Remarks. The only peculiarity of variety *mutila* is the absence of mucus surrounding the fertile whorls. BRAUN established this variety on account of its being not more than twice furcate. After my having studied the type I stated that many of the branchlets are three and even four times divided. Therefore, these plants are quite identic with those from Java, China and Bengal cited in the "Fragmente" (1882, pp. 54—56). It is much variable in habit.

The decoration of the oospore membrane is discussed under var. *mucosa*.

Ecology. In lakes, rivers, pools, rice-fields, swamps, and ditches, usually not together with other *Charophyta*; only *Chara corallina* and *C. Braunii* were found growing together with it. The label of the specimen from the Toba lake has, in addition, the following notes: temp. of surface 27°.5 C., pH 5.5, conductivity $0.06 . 10^{-4}$. Specimens with ripe oospores are found from October to June. It probably prefers mountainous areas.

Distribution. Between 35° N. and 38° S.; ASIA, India; Indo-China; Malaysia: Malay Peninsula, Sumatra, Java, Borneo, Amboina, New Guinea. Moreover in lit.: China, BRAUN &

NORDSTEDT (1882, p. 55); Japan, T. F. ALLEN (1898, p. 79, var. *ramuscula*), MIGULA (1930, p. 212) — AUSTRALIA, Queensland, NORDSTEDT (1889, p. 24, f. *australiana*), BAILEY (1909, p. 6); GROVES & ALLEN (1937, p. 44); Victoria, NORDSTEDT (1918, p. 3).

12. Nitella moniliformis ZANEV., nov. spec.

Illustrations. The pres. paper, figs. 2*a*—*c*.

Planta monoica, gracilis, humilis, moniliformis, brunneo-viridis, ad 15 cm alta. *Caulis* tenuis, 150—300 μ in diam. *Internodia* quam ramuli 1—2-plo longiora. *Verticillorum ramuli* steriles fertilibus similes, capita formantes, c. 0.7 cm diam., plerumque 4-, interdum 3- ad 5-furcati, 0.5 cm longi; radii primarii 6—7, longitudine ½ totius ramuli; radii secundarii 5—6; radii tertiarii 5—6; radii quaternarii 4—5; radii quintarii (dactyli) 3—5. *Dactyli* plerumque 3—5, plus minusve aequales, bicellulati, cellula inferior 250—530 μ longa, 35—55 μ lata, cylindrica, apice rotundata, cellula superior acuminata, 35—70 μ longa, basi 8—17 μ lata. ♂ et ♀ *gametangia* ad omnes furcationes posita, haud muco circumfusa. *Antheridia* solitaria, terminalia, c. 180 μ diam. *Oogonia* 1—3 aggregata, ad nodos liberos posita, 240—270 μ longa (coronula inclusa), 204—235 μ lata, striis (5—)6; *coronula* persistens, connivens, 50—60 μ alta, basi 65—90 μ lata; *oosporae* aureo-brunneae, 180—225 μ longae, 155—195 μ latae, striis (4—)5; oosporae *membrana* tuberculata.

Plant monoecious, graceful, delicate, remarkably moniliform, up to 15 cm high, brownish green, not at all incrusted, in a dried state extremely felty. *Stem* very slender, 150—250 μ in diam. *Internodes* 1—2 times as long as the branchlets. *Sterile* and *fertile* branchlets similar, forming roundish dense heads of c. 0.7 cm diam., 6—7 in a whorl, c. 0.5 cm long, frequently four, sometimes three to five times furcate; primary rays half as long as the entire branchlet; secondary rays 5—6, which are frequently all forked into 5—6 tertiary rays; these are all again divided into 4—5 quaternary rays, of which one or two have a fourth furcation with 3—5 uniform quinary rays. *Dactyls* 3—5, always two-celled, rigid, basal cell 250—530 μ long, 35—55 μ wide, cylindrical, rounded at the apex, upper cell conical, somewhat curved, 35—70 μ long, 8—17 μ wide at base. ♂ and ♀ *gametangia* sessile, at all free nodes of the branchlets, not enveloped in a mucous cloud. *Antheridia* solitary, terminal, c. 180 μ in diam., earlier ripe than oogonia. *Oogonia* 1—3 together, when young globular, 240—270 μ long (incl. coronula), 204—235 μ wide; *spiral-cells* showing (5—)6 convolutions; *coronula* persistent, 50—60 μ high, 65—90 μ wide at

base, individual cells strongly connivent; *oospores* bright golden-brown, 180—225 μ long, 155—195 μ wide, with (4—)5 ridges; *outer membrane* tuberculate, the bases of the rather large tubercles being joined by means of small threads.

JAVA: W. Priangan, Tjitibo, Tjidadap, 1000 m alt., abundant in rice-fields and swamps, 21 II 1917, BAKHUIZEN VAN DEN BRINK 2586 (Bz), *type*.

Remarks. This small, graceful, and when dried, felty species, is at once recognized by its moniliformous habit. Its most striking features are the aggregated oogonia and the tuberculate oospore membrane, which were not yet known from any monoecious species of the strictly bicellulate macrodactylous group. *N. moniliformis* resembles somewhat *N. batrachosperma* and small forms of *N. tenuissima* (var. *byssoides*), but differs from both in the above cited characters, and, moreover, in the higher degree of furcation of the branchlets and in the fertile first node respectively.

Ecology. "Below the surface" of the water, in "rice-fields" and "swamps", are notes given on the herbarium label. Ripe oospores are found in February.

Distribution. On 7° S.; ASIA, Malaysia: Java.

13. **Nitella batrachosperma** [1]) (REICHENBACH) A. BRAUN in N. Denkschr. Schweiz. Ges. Naturw. 10, 1849, p. 10 (*nom. tant.*); id. in COHN's Krypt. Fl. Schles., 1876, p. 400; BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, pp. 12, 66; J. GROVES in Journ. Linn. Soc., Bot., 46, 1924, pp. 362, 367; G. O. ALLEN in Journ. Bombay Nat. Hist. Soc. 30, 1925, p. 597; id. in Journ. Ind. Bot. Soc. 7, 1928, p. 58, text-fig. 6; PAL in Journ. Burma Res. Soc. 18, 1929, p. 113 (*nom. tant.*); id. in Journ. Linn. Soc., Bot., 49, 1932, pp. 64, 71. — *Chara batrachosperma* REICHENBACH, Iconogr. Bot. 8, 1830, pl. 794; id., Fl. Germ. exsicc., 1830, p. 148 — *Nitella confervacea* A. BRAUN, Consp. syst. Charac. europ., 1867, p. 2; BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, pp. 12, 64; HY in Bull. Soc. bot. France 52, 1905, p. 94.

Plant monoecious, extremely small and delicate, c. 5 cm high. *Internodes* 1—4 times the length of the branchlets. *Sterile* and *fertile branchlets* similar, 8 in a whorl, twice, occasionally thrice furcate; secondary rays 4—6. *Dactyls* 3—7, uniformly two-celled, frequently more than half the length of the entire branchlet. ♂ and ♀ *gametangia* at the first and occasionally at the second branchlet-node, sometimes enveloped in mucus, solitary. *Antheridia* 175—200 μ in diam. *Oospores* dull yellow-brown, 225—300 μ long, with 6—8 ridges. *Membrane* at first finely granulate, subsequently reticulate.

Remarks. Different from the closely allied *Nitella gracilis* and *N. tenuissima*

[1]) The literature here mentioned concerns only the area under discussion; an extensive list of publications, illustrations and synonyms (not seen by the author) is to be found in MIGULA (1897, pp. 182, 184) and in GROVES & BULLOCK WEBSTER (1920, p. 124).

by the uniformly two-celled dactyls, and from *N. moniliformis* and *N. pseudoflabellata* by the less furcate branchlets. No Malaysian specimens examined.

Ecology. Occurring in shallow pools on very fine mud and on decaying filamentous algae.

Distribution. Between 43° N. and 30° S.; EUROPE — ASIA, India: Gangetic Plain, GROVES (1924, p. 367), G. O. ALLEN (1925, p. 597); Burma, PAL (1932, p. 71); Japan — N. AMERICA — AUSTRALIA.

14. Nitella dictyosperma H. & J. GROVES in Journ. Linn. Soc., Bot., 33, 1898, p. 324, pl. 19; id. in URBAN, Symb. Antill. 7, 1911, pp. 30, 35; PAL in Journ. Linn. Soc., Bot., 49, 1932, pp. 64, 74.

Plant monoecious, slender. *Internodes* somewhat exceeding the branchlets in length. *Branchlets* 6 in a whorl; *sterile branchlets* twice furcate, secondary rays 3; *fertile branchlets* 2—3 times furcate, secondary rays 3—4. *Dactyls* 3, usually one of them abbreviated; two-celled. ♂ and ♀ *gametangia* together at the second and third branchlet-nodes, solitary, not enveloped in mucus. *Antheridia* 270—300 μ in diam. *Oospores* brown, c. 280 μ long, with 6 ridges. *Membrane* reticulate.

Remarks. Akin to *Nitella oligospira*, but different in having all dactyls elongated except occasionally one. No specimens examined.

Ecology. In ponds and canals.

Distribution. Between 17° N. and 15° N.; ASIA, India: Burma — AMERICA, C. Am.: Antigua, Guadeloupe.

15. Nitella flagellifera GROVES & ALLEN in Journ. Bot. 65, 1927, p. 337; G. O. ALLEN in Journ. Ind. Bot. Soc. 7, 1928, p. 59, pl. 4.

Plant monoecious, medium-sized. *Internodes* not much longer than the branchlets. *Sterile* and *fertile* branchlets similar, 6 in a whorl, thrice furcate, up to 8 cm long; secondary rays 6. At the first two branchlet-nodes an accessory fertile branchlet is produced. *Dactyls* 3—4, two-celled. ♂ and ♀ *gametangia* together at the second and third branchlet-nodes, not at the first one or at the base of the whorls, solitary, not enveloped in mucus. *Antheridia* c. 250 μ in diam. *Oospores* dull orange-yellow, c. 325 μ long, with 7 ridges. *Membrane* imperfectly reticulate.

Remarks. The outstanding feature of this species is the production of a separate little fertile branchlet at the first and second branchlet-node of the stem-whorls. No specimens examined.

Ecology. In a pond, in the early cold season.

Distribution. 30° N.; ASIA, India: Gangetic Plain.

16. Nitella patula GROVES & ALLEN in Journ. Bot. 65, 1927, p. 338; G. O. ALLEN in Journ. Ind. Bot. Soc. 7, 1928, p. 59.

Plant monoecious, rather large. *Sterile* and *fertile branchlets* similar, 6 in a whorl, 3—4 times furcate; secondary rays 6—7. *Dactyls* 2—3, two-celled. ♂ and ♀ *gametangia* together at the second and third branchlet-nodes, solitary, not enveloped in mucus. *Antheridia* c. 275 μ in diam. *Oospores* light-brown, c. 375 μ long, with 7 ridges. *Membrane* finely and regularly granulate.

Remarks. Distinguishable from the closely allied *Nitella furcata* by having solitary oogonia and a larger number of furcations, and from *N. oligospira* by having a granulate oospore membrane. No specimens examined.

Ecology. In the open middle portion of a small pond surrounded by dense masses of rushes, and drying up rapidly between the rainy and cold seasons.

Distribution. 30° N.; ASIA, India: Gangetic Plain.

17. Nitella leptodactyla J. GROVES in Journ. Linn. Soc., Bot., 46, 1922, p. 99, pl. 6; id. in Journ. Linn. Soc., Bot., 48, 1928, p. 132 (var. *megaspora*); G. O. ALLEN in Journ. Ind. Bot. Soc. 7, 1928, p. 57; ZANEVELD in Blumea 3, 1939, p. 381 (var. *megaspora*).

Plant monoecious, slender, up to 30 cm high. *Internodes* 2—5 times the length of the branchlets. *Sterile* and *fertile branchlets* similar, 6—7 in a whorl, 2—4 times furcate; secondary rays 7. *Dactyls* 3—5, two-celled. ♂ and ♀ *gametangia* together at the second and third branchlet-nodes, sometimes enveloped in mucus, solitary. *Antheridia* c. 225 μ in diam. *Oospores* red-brownish black, c. 228 μ long, with 7—8 ridges. *Membrane* granulate.

Remarks. Characterized by the sterile first node, the granulate oospore membrane and the number of secondary rays, and thereby distinguishable from *N. pseudoflabellata* and its near allies. The var. *megaspora* was collected in Madagascar only and has oospores of 275—400 μ length. No specimens examined.

Ecology. In a pond, in November.

Distribution. Between 30° N. and 20° S.; ASIA, India: Gangetic Plain; Ceylon — AFRICA, Madagascar.

18. Nitella Wattii J. GROVES in Journ. Linn. Soc., Bot., 46, 1924, p. 361, pl. 36.

Plant monoecious, slender, c. 20 cm high. *Internodes* 1—3 times the length of the branchlets. *Sterile* and *fertile branchlets* similar, 6—7 in a whorl, 3—4 times furcate; secondary rays 6—7. *Dactyls* 5—6, uniformly two-celled. ♂ and ♀ *gametangia* together at the second and third branchlet-nodes, solitary, enveloped in mucus. *Antheridia* c. 225 μ in diam. *Oospores* chestnut-brown, c. 200—225 μ long, with 7—8 ridges. *Membrane* with vermiformous decoration.

Remarks. The outstanding features of this species are the unequal length of the branchlets in the same whorl, and the much abbreviated penultimate rays, surpassed by the clusters of dactyls. No specimens examined.

Ecology. Unknown.

Distribution. On c. 25° N.; ASIA, India: Gangetic Plain.

19. Nitella oligospira A. BRAUN in Monatsber. Kön. Akad. Wiss. Berlin, 1858, p. 357; id. in ZELLER in Journ. Roy. As. Soc. Bengal, 2, 1873, p. 193; id. in Abh. Kön. Akad. Wiss. Berlin, 1882, pp. 13, 67; T. F. ALLEN, Charac. America 1, 1888, p. 47 (*nom. tant.*); NORDSTEDT in Hedwigia 27, 1888, p. 194; id. in Act. Univ. Lund. 25, 1889, p. 11; id. in Proc. Roy. Soc. Vict., N. S., 31, 1918, p. 3 (*nom. tant.*); J. GROVES in Journ. Linn. Soc., Bot., 46, 1922, p. 100; id. in Journ. Linn. Soc., Bot., 46, 1924, pp. 362, 368; PAL in Journ. Burma Res. Soc. 18, 1929, p. 113 (*nom. tant.*); MIGULA in Hedwigia 70, 1930, p. 213; DIXIT in Journ. Ind. Bot. Soc., 10, 1931, p. 205; AGHARKAR & KUNDU in Journ. Dep. Sci., N. S., 1, 1937, pp. 3, 7 — *Nitella oligospira* f. *australiana*, f. *genuina*, var. *australiensis*; *Nitella javanica*; cf. formae.

Illustrations. BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, pl. 2, figs. 50—52; AGHARKAR & KUNDU in Journ. Dep. Sci., N. S. 1, 1937, pl. 3, figs. 15—18.

Plant monoecious, greyish to bright-green, lax, c. 25 cm high. *Stem* rather slender to moderately stout, 320—380 μ in diam. *Internodes* 0.5—3 times the length of the branchlets. *Sterile branchlets* 6—7 in a whorl, c. 1.5 cm long, rigid, spreading, (2—)3(—4) times furcate; primary rays $^1/_2$—$^1/_3$ as long as the entire branchlet; secondary rays 4—5; tertiary rays 2—3 of which 1—2 are again forked with 1—3 quaternary rays. *Fertile branchlets* 5—7 in a whorl, tufted, 2.5—3 cm long, 4(—5) times furcate; primary rays $^1/_3$ the length of the branchlet; secondary rays 5—7; tertiary rays 3—4, most of them again furcate into 2—3 quaternary rays; sometimes 1—2 of these give rise to 1—2 quinary rays. *Dactyls* 1—3, two-celled, varying in length, some are very short, others very long, lower cell cylindrical, 45 μ wide, extremely variable in length, rounded or truncate at apex; ultimate cell conical, 55—130 μ long, 25—40 μ wide at base, acuminate. ♂ and ♀ *gametangia* sessile, at all and the same free nodes, the ultimate one sometimes excepted, viz. when all dactyls are abbreviated; not enveloped in a mucous cloud, solitary. *Antheridia*, terminal, 208—310 μ in diam. *Oogonia* lateral, 384—560 μ long (incl. coronula), 365—460 μ wide; *spiral-cells* showing 7—8 convolutions; *coronula* 30—40 μ high, 27—38 μ wide at base, persistent, the cells of both rows equal in length; *oospores* light-brown, 260—400 μ long, 215—365 μ wide, with 6—7 broad ridges; *membrane* reticulate.

Remarks. *Nitella oligospira* is a rather variable species especially with regard to the length of the dactyls, the furcation of the branchlets, and the size of the ripe oospores. Formerly BRAUN combined this and the nearly related species (cf. our key) under the name of *Nitella polyglochin sens. lat.* (1882, p. 13). The special features of *N. oligospira* are the solitary oogonia, the short, persistent coronula (the upper row of cells as high as the lower one), and the dactyls having proportionally few short cells. The ultimate node is not always sterile, as is mentioned by GROVES (1924, p. 362) in his key for the Indian *Charophyta*. In studying the types of the forms distinguished by BRAUN, it became obvious that this author used to classify a plant under this species, in all those cases, in which abbreviated dactyls, however few, were extant.

As will be seen below, I share BRAUN's opinion in distinguishing the forms *javanica* and *indica* although transitional specimens occur,

e. g. the Javanese plant from Madjapahit. The form *australiana* of NORDSTEDT has probably to be united with f. *indica,* and f. *genuina* of NORDSTEDT (which name was only published in the key of NORDSTEDT in the "Fragmente" — 1882, p. 13 — and in T. F. ALLEN's translation thereof — 1888, p. 47 —) with f. *javanica,* but not having seen the types I should prefer to reserve judgement. The variety *Wrightii,* also distinguished by BRAUN, is not mentioned in NORDSTEDT's key and from the descriptions it seems to occupy an intermediate position between f. *indica,* with which the size of the oospores agree, and f. *javanica,* with which it has in common the number of branchlet-furcations and the diameter of the stem.

Ecology. In small rivers, creeks, and holes in a small stream. Somewhat mountainous areas are preferred.

PAL (1932, p. 51) gives for the seasonal distribution in Burma the months November to March, in which period ripe oospores may be found. In Salsette (Bombay), according to DIXIT (1931, p. 205), ripe oospores are present from August to March. In Malaysia mature oospores were collected in July (cf. f. *javanica*), and immature ones in February and August (cf. f. *indica*).

Distribution. Between 35° N. and 28° S.; ASIA, India: India Deserta, Bengal, Ceylon; Pegu; Nicobar Islands; Malaysia: Malay Peninsula, Java, New Guinea, cf. forms. Moreover in lit.: Japan, MIGULA (1930, p. 213); ?China: Hongkong, ex GROVES (1911, p. 36); India: Assam, GROVES (1924, p. 368); Burma, PAL (1932, p. 75) — AMERICA, N. Am.: Texas, BRAUN & NORDSTEDT (1882, p. 70, var. *Wrightii*); ? Georgia, ex GROVES (1911, p. 36); C. Am.: Cuba, GROVES (1911, p. 36); Porto Rico, NORDSTEDT (1888, p. 194; 1889, p. 11), GROVES (1911, p. 36); S. Am.: Venezuela; Caracas, cf. f. *indica,* BRAUN (1858, p. 351); Brazil, cf. f. *indica* — AFRICA, Comoro Islands, BRAUN & NORDSTEDT (1882, p. 68, f. *genuina*) — AUSTRALIA, Queensland, cf. f. *indica.*

f. 1. **javanica** A. BRAUN in Abh. Kön. Akad. Wiss. Berlin, 1882, pp. 13, 68; T. F. ALLEN, Charac. America 1, 1888, p. 47 (*nom. tant.*); NORDSTEDT in Act. Univ. Lund. 25, 1889, p. 11; DE WILDEMAN, Prodr. Flor. Alg. Ind. Néerland., 1897, p. 31; id., Suppl. et Tabl. Stat., 1899, p. 98; id., Alg. Flor. Buitenzorg, 1900, p. 375 — ? *Nitella oligospira* A. BR. f. *genuina* NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 13 (*nom. tant.*); T. F. ALLEN, Charac. America 1, 1880, p. 47 (*nom. tant.*) — *Nitella javanica* HASSKARL in herb. (B, Bz).

Illustrations. BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss.

Berlin, 1882, pl. 5, figs. 133—134; NORDSTEDT in Act. Univ. Lund. 25, 1889, f. 30, f. 31 (f. *genuina*); DE WILDEMAN, Alg. Flor. Buitenzorg, 1900, f. 140.

Plants rather slender. *Stem* up to c. 500 μ in diam. *Branchlets* 2—3 times furcate. *Oospores* (290—)330—350 μ long.

INDIA: Bengal, without exact locality and date, com. 1869, KURZ 1930 (B).

JAVA: Priangan, Geger Bentang, at the base of G. Gedeh, 1350 m alt., VII 1855, HASSKARL s.n. (B), *type*, in (Bz) is probably a duplicate from the type, as it has a note by HASSKARL: "*Nitella javanica* HSSKL an *Ch. polyclados* DON.?"

Remarks. In his type description BRAUN states that the branchlets are only twice furcate. This is not quite correct as there are also thrice furcate ones. BRAUN gives 120—140 μ as the size for the diam. of the antheridia, but these were probably not fully ripe, ripe antheridia having a diam. of c. 260 μ.

The f. *javanica* is distinguished from f. *indica* in having smaller oogonia and fewer furcate branchlets, and from f. *genuina* only in having larger oogonia, reason why this form most probably is to be regarded a synonym. The size of the oospores varies from 290—350 μ.

Distribution. Between 25° N. and 13° S.; ASIA, India: Bengal; Malaysia: Java. Moreover in lit.: Ceylon, BRAUN & NORDSTEDT (1882, p. 69).

f. 2. **indica** A. BRAUN in Abh. Kön. Akad. Wiss. Berlin, 1882, pp. 13, 69; T. F. ALLEN, Charac. America 1, 1888, p. 47 (*nom. tant.*); NORDSTEDT in Hedwigia 27, 1888, p. 183; GUTWINSKI & NORDSTEDT in Bull. Int. Ac. Sci. Cracovie, Cl. Math. Nat., 1902, p. 578 — ? *Nitella oligospira* A. BR. f. *australiana* NORDSTEDT in Act. Univ. Lund. 25, 1889, p. 26; GROVES & ALLEN in Proc. Roy. Soc. Queensl., 46, 1935, pp. 40, 47 — *N. oligospira* A. BR. var. *australiensis* BAILEY, Compreh. Catal. Queensl. Pl., 1909, p. 678.

Illustrations. BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, pl. 5, figs. 135—136.

Plants moderately stout. Diam. of the *stem* up to 880 μ. *Branchlets* 3—5 times furcate. *Oospores* 360—400 μ long.

INDIA: India Deserta, Lahore, no date, com. 1869, KURZ 2721 (B).

MALAY PENINSULA: Pegu, Kya Eng, 28 XII 1870, KURZ 3294 (B), *type*.

NICOBAR ISLANDS: Island of Kamorta, in a little river in a grassy plain, II 1875, KURZ 3918 (B), oospores immature.

JAVA: Batavia, in the river Tjiliwoeng (on the label is written: "Tjaljum"), 29 VIII and 7 IX 1877, DE LA SAVINIERRE 674 (K), a sterile, robust specimen, badly preserved; Kediri, Madjapahit, (on the label "Modjopait"), without date, TEIJSMANN s.n. (B, Bu-Mus, K).

NEW GUINEA: Papua, Kanosira, holes in a small stream in savannah woods, c. 150 m alt., 23 II 1935, CARR 11488 (B, L), sterile specimens.

Remarks. The plant of Madjapahit has the branchlets thrice furcate, and the ripe oospores are 360—390 μ long. NORDSTEDT gives in his key their length in the form *indica* as 390—400 μ. Therefore the plant of TEYSMANN is a transition towards the smaller *javanica*. In most of the other specimens the oospores are, if any, immature, but on account of their habit and the number of furcations they are inserted here. The CARR specimen from New Guinea has a remarkably bright green colour and is much fixed to the sheet.

Most probably NORDSTEDT's form *australiana* and BAILEY's var. *australiensis* (the same plant, but it is cited as a variety and the name is differently written) belong to this form. Though the plant has immature oospores, it has the usual number of furcations.

Distribution. Between 30° N. and 28° S.; ASIA, India; Nicobar Islands; Malaysia: Malay Peninsula, Java, New Guinea. Moreover in lit.: India: Bengal, GROVES (1924, p. 368); AUSTRALIA, Queensland, NORDSTEDT (1889, p. 26), BAILEY (1909, p. 678), GROVES & ALLEN (1935, p. 47).

20. Nitella burmanica PAL in Journ. Linn. Soc., Bot., 49, 1932, pp. 65, 77, pl. 12.

Plant monoecious, up to 30 cm high. *Internodes* 2—4 times the length of the branchlets. *Sterile branchlets* large, 6—7 in a whorl, 2—3 times furcate; secondary rays 3—4. *Fertile branchlets* short, 5—6 in a whorl, 4 times furcate; secondary rays 6. *Dactyls* 2—3, two-celled. ♂ and ♀ *gametangia* together at all branchlet-nodes and at the base of the whorls, aggregated, not enveloped in mucus. *Antheridia* 350 μ in diam. *Oospores* golden-brown, 300 μ long, with 6 ridges. *Membrane* not described.

Remarks. Closely allied to the other brachydactylous species, but characterized by the clustered oogonia and the fertile base of the whorls of branchlets. No specimens examined.

Ecology. In road-side ponds; ripe oospores were found not earlier than November.

Distribution. 16°30′ N.; ASIA, India: Burma.

21. Nitella tumulosa ZANEV., nov. spec.

Planta monoica, gracilis, cinereo-viridis, ad 25 cm alta. *Caulis* tenuis, usque ad 1000 μ diam. Internodia $^1/_3$—3-plo longitudine ramulorum. *Verticillorum ramuli* steriles fertilibus ± similes, normaliter 6, 3—4-plo furcati; radii primarii elongati, tertia parte longitudinis totius rami longi; radii secundarii normaliter 5—6; radii tertiarii 3—5; radii quaternarii 2—4; radii quintarii 3—1. *Dactyli* 3—1, bicellulati, cellula inferiore allantoidis, quam cellula superior leviter curvata conica permulto longior. *Antheridia* sessilia, terminalia, 230—355 μ diam. *Oogonia*

ad omnes nodos liberos posita, aggregata, 330—540 μ longa (coronula inclusa), 230—400 μ lata, striis 6—8, latissimis; *coronula* 40—89 μ alta, basi 50—102 μ lata; *oosporae* luteo-brunneae, 245—400 μ longae, 225—320 μ latae, striis 5—6; oosporae *membrana* tuberculata.

Plant monoecious, slender, of medium stature, up to 25 cm high, greyish green. *Stem* moderately stout, up to 1000 μ in diam. *Internodes* in the lower parts $^1/_3$—1, in the upper parts 1—3 times the length of the branchlets. *Sterile* and *fertile* branchlets ± similar, 6 in a whorl, 1—2 cm long, 3—4 times furcate; primary rays $^1/_3$ as long as the entire branchlet; secondary rays usually 5—6; tertiary rays 3—5; frequently all furcate into 2—4 quaternary rays; penultimate rays normally longer than the secondary and tertiary ones and frequently all forked into 3—1 quinary rays; all rays with exception of the ultimate one elongate, long and narrow. *Dactyls* 3—1, two-celled, some elongate, some very short, curved, inferior cell up to 1300 μ long and c. 120 μ wide, cylindrical and tapering at the apex, which has the same width as the base of the ultimate cell; ultimate cell conical, curved, 55—400 μ long, 12—57 μ wide at base. ♂ and ♀ *gametangia* produced at all free nodes, but rarely at the uppermost one and never at the base of the whorls, not enveloped in mucus. *Antheridia* solitary, strictly terminal, but sometimes seemingly lateral, 230—355 μ in diam., earlier ripe than the oogonia. *Oogonia* 1—6 together, irregularly ripening, 330—540 μ long (incl. coronula), 230—400 μ wide, *spiral-cells* showing 6—8 convolutions; *coronula* persistent, 40—89 μ high, 50—102 μ wide at base, individual cells of both rows small and of the same size, connivent, *oospores* bright-brown, 245—400 μ long, 225—320 μ wide with 5—6 ridges; *outer membrane* tuberculate.

R e m a r k s. The present new species has much resemblance with *Nitella orientalis* from Japan and Australia, but is different by the tuberculate oospore membrane (giving the impression of tumuli), and the occurrence of gametangia at the first branchlet-node. It has also much likeness with *N. microcarpa*, which is at once distinguished by the reticulate NORDSTEDT-markings and, moreover, by its 2—3-celled dactyls.

N. orientalis and *N. tumulosa* are akin in the variable length of the inferior cell of the dactyls; therefore both species are links between the macro- and the brachydactylous species of the *Bicellulatae*.

The plants belonging to this species are collected at two different localities and are different in the size of the gametangia. I have therefore distinguished the varieties *typica* and *pumila*.

Ecology. The plants are heavily covered with clay and diatoms.

Distribution. Between 4° N. and c. 28° S.; Asia, Malaysia: Sumatra, Java.

var. α **typica** Zanev., nov. var.

Illustrations. The pres. paper, figs. 5*a, c.*

Planta robustior. *Antheridia* c. 300—355 μ diam., terminalia, saepe simulate lateralia. *Oogonia* 425—540 μ longa (coronula inclusa); 340—400 μ lata; striis 7—8; *coronula* 68—89 μ alta, basi 78—102 μ lata; *oosporae* 340—405 μ longae, 280—320 μ latae, striis 6.

Java: without exact locality, date, and collector's name (probably Korthals), ex herb. Blume ? (L), in Herb. Lugd. Bat. under no 936, 254 ... 256, *type.*

Remarks. A peculiarity of this variety is the seemingly lateral insertion of the antheridia, as they move over to one side, however, they are terminally produced. The internodes are $^1/_3$—$1^1/_2$ times the length of the branchlets.

Distribution. Between c. 6° N. and c. 28° S.; Asia, Malaysia: Java.

var. β **pumila** Zanev., nov. var.

Illustrations. The pres. paper, fig. 5*b.*

Planta mediocriter robusta. *Antheridia* 230—265 μ diam., terminalia. *Oogonia* 330—365 μ longa (coronula inclusa), 230—260 μ lata; striis 6—7; *coronula* 40—60 μ alta, basi 50—72 μ lata; *oosporae* 245—285 μ longae, 225—255 μ latae, striis 5—6.

Sumatra: Riouw & Depend., Natoena Islands, Island of Boengoeran, E. slope of G. Ranai, 250 m alt., in a stream, 10 IV 1928, van Steenis 1157 (Bz), *type.*

Remarks. The internodes of this var. are frequently 1—3 times as long as the entire branchlets, and therefore much longer than in var. *typica.*

Ecology. Very frequent in a swift flowing stream.

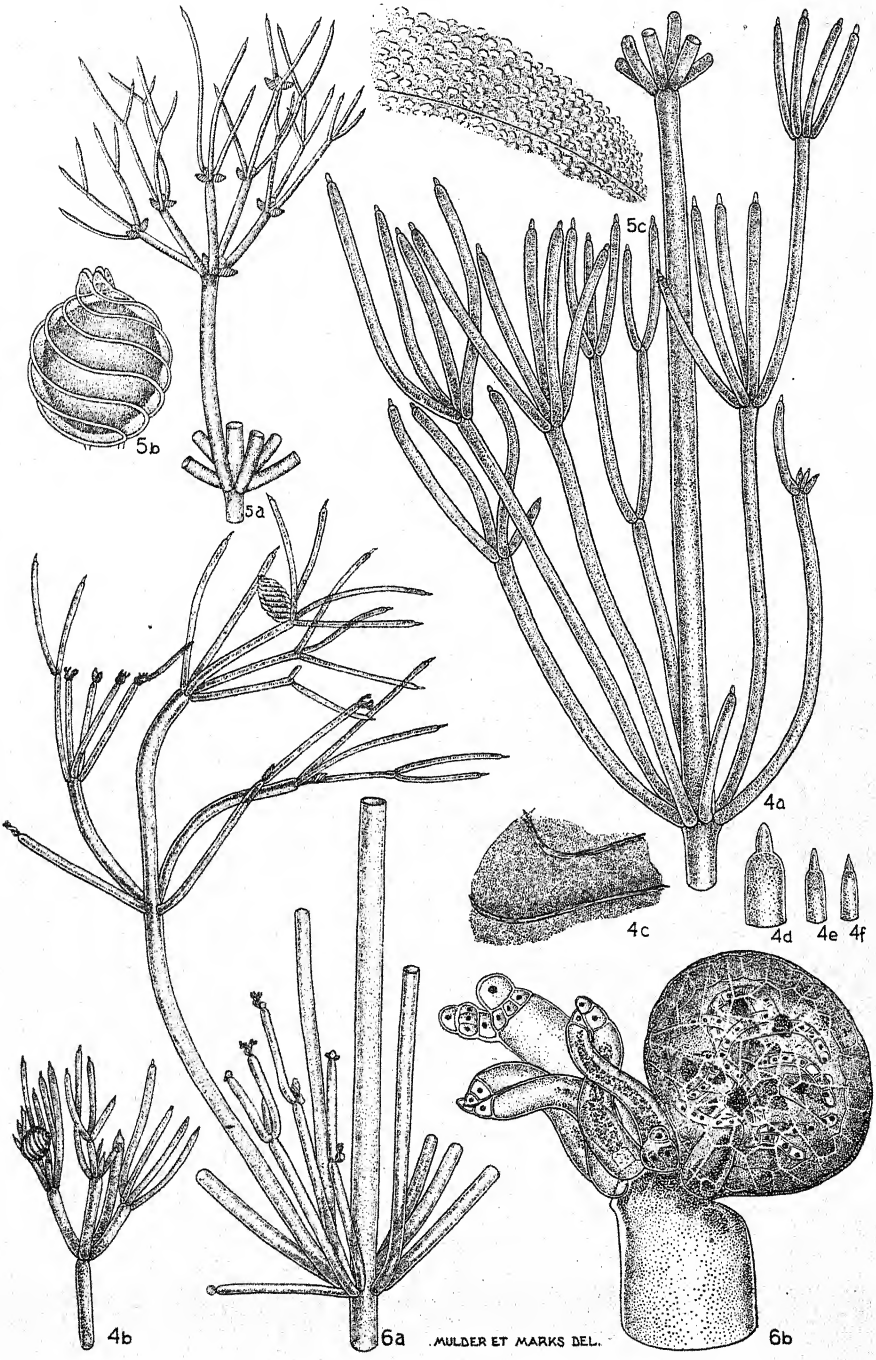
Distribution. On 4° N.; Asia, Malaysia: Boengoeran.

22. Nitella furcata (Roxburgh apud Bruzelius) Agardh, Syst. Alg., 1824, p. 124; Griffith, Not. Plant. Asiat. 2, 1849, p. 280; Kuetzing,

---

Fig. 4, *Nitella sumatrana*; *a.* whorl of sterile branchlets, × c. 7; *b.* fertile branchlet, × c. 50; *c.* decoration of oospore membrane, × c. 165; *d—f.* apices of the two-celled dactyls (sterile whorls), × c. 4 — Fig. 5, *Nitella tumulosa*, n. sp.; *a.* (var. *typica*) stem-node with fertile branchlet, × c. 6; *b.* (var. *pumila*) mature oogonium, × c. 75; *c.* (var. *typica*) decoration of oospore membrane, × c. 225 — Fig. 6, *Nitella mucronata* var. *pseudograciliformis*; *a.* stem-node with fertile branchlet, × c. 8; *b.* apex of a ray with an antheridium, an immature oogonium (note the 4 spiral-cells) and a young branchlet, × c. 125.

Pl. 2



Spec. Alg., 1849, p. 513; J. GROVES in Journ. Linn. Soc., Bot., 46, 1924, pp. 362, 368; id. in Journ. Bot. 65, 1927, p. 338; G. O. ALLEN in Journ. Ind. Bot. Soc. 7, 1928, p. 58; J. GROVES in Journ. Linn. Soc., Bot., 48, 1928, p. 132; PAL in Journ. Burma Res. Soc. 18, 1929, p. 113 (*nom. tant.*); id. in Journ. Linn. Soc., Bot., 49, pp. 65, 78; MUKERJI in Proc. 21st Ind. Sci. Congr., Bombay, 1934, p. 295; GROVES & ALLEN in Proc. Roy. Soc. Queensl., 46, 1935, pp. 41, 48; ALLEN & HERTER in Rev. Sudamer. Bot. 1, 1934, p. 88 (?); DIXIT in Journ. Ind. Bot. Soc. 14, 1935, p. 257; AGHARKAR & KUNDU in Journ. Dep. Sci., N. S. 1, 1937, pp. 3, 9; ZANEVELD in Blumea 3, 1939, pp. 379, 382 — *Chara furcata* ROXBURGH apud BRUZELIUS (non *Chara furcata* HORNEMANN), Observ. gen. Chara, 1824; BRUZELIUS & FUERNROHR in Flora 9, 1826, p. 491; ROXBURGH, Flor. Indica 3, 1832, p. 564; ZOLLINGER, Syst. Verz. Ind. Arch. Ges. Pfl., 1, 1854, p. 4; BRAUN in Monatsb. Kön. Akad. Wiss. Berlin f. 1867, p. 816, note 1, 1868 (*nom. tant.*); ROXBURGH, Flor. Indica, 1874, p. 648; DE WILDEMAN, Prodr. Fl. Alg. Ind. Néerl., Suppl. et Tabl. Stat., 1899, p. 13 — *Nitella polyglochin* f. *japonica*, f. *javanica*, var. *nicobarica*, var. *Roxburghii*, var. *Zollingeri*, var. *Zollingeri* f. *nicobarica*; *Nitella Roxburghii*; *Chara Roxburghii*; cf. varieties.

Illustrations. G. O. ALLEN in Journ. Ind. Bot. Soc. 7, 1928, pl. 4 and text-f. 7; AGHARKAR & KUNDU in Journ. Dep. Sci., N. S. 1, 1937, pl. 3, figs. 19—22.

Plant monoecious, dark to greyish green, up to 20 cm high. *Stem* slender to stout, 400—1100 μ in diam. *Internodes* 0.5—2 times the length of the branchlets. *Sterile branchlets* 6 in a whorl, spreading, 2—3.5 cm long, 2—4 times furcate; primary rays usually half as long as the entire branchlet; secondary rays (3—)4(—6), of which 1—2 are again forked into 2—3 tertiary rays; some of them again furcate into 2—3 quaternary rays; quinary rays, if any, 1—3. *Fertile branchlets* 6 in a whorl, 1—2.5 cm long, much more compact than the sterile ones, 2—3 times furcate; primary rays ½—¼ the length of the entire branchlet; secondary rays 3—6, of which 1—3 are again forked into 2—3 tertiary rays; some of them again furcate into 1—3 quaternary rays. *Dactyls* (1—)2(—3), two-celled, divergent, inferior cell up to 225 μ long, and 75 μ wide at base, though always abbreviated, somewhat varying in length, sometimes somewhat globular, tapering to the distal end, which has the same breadth as the base of the ultimate cell; ultimate cell conical, 75 μ long, 15—45 μ wide at base. ♂ and ♀ *gametangia* at all and the same free nodes, except the ultimate one, sessile, not surrounded by a mucous cloud. *Antheridia*

solitary, terminal, earlier ripe than the oogonia, 220—280 μ in diam. *Oogonia* 2—4 together, 240—450 μ long (incl. coronula), 220—320 μ wide, *spiral-cells* showing 8—9 convolutions; *coronula* 60—105 μ high, c. 90 μ wide at base, individual cells of the upper row much longer than those of the lower row, acuminate; *oospores* golden-brown, 190—300 μ long, 180—270 μ wide, with 6 broad ridges; *outer membrane* reticulate.

Vernacular name: Janj, (Bengal), which is, according to ROXBURGH (1832, p. 564), the general name for all such aquatic plants.

Remarks. The plants belonging to this species exhibit much variation in their habit, and in the size of the oospores, though the variation of the latter is less pronounced than in *N. microcarpa*. This is considered sufficient ground for the distinction of three varieties, i. e. *Roxburghii, Zollingeri,* and *nicobarica*. However, most authors did not state to which variety their plants belong; therefore I have cited that part of the literature at the head of the species.

The characteristic feature of *N. furcata* is the elongate upper row of coronula-cells, often more than twice the length of the lower row. These cells are in old plants spreading, but in young plants connivent. By this character it is distinguished from the other brachydactylous species, *N. mauritiana, N. guineensis* and *N. japonica* excepted, which are, moreover, different, the former two by their solitary oogonia, and the latter by its tuberculate oospore membrane. As I have not seen a specimen of MIGULA's *N. polyglochin* f. *japonica* (1930, p. 213) I cannot conclude as to an identity with *N. japonica* as was suggested by FILARSZKY (1934, p. 712); the size of the oospores differs considerably: those of *N. japonica* are 340 μ long, and those of *N. polyglochin* f. *japonica* only 250 μ.

Some confusion has been introduced into the nomenclature by BRAUN's attempt to establish the appropriate name of *N. polyglochin* for the collective species *furcata* (1882, p. 73), including the varieties *Roxburghii* and *Zollingeri,* and the form *nicobarica,* which is cited in NORDSTEDT's key as a variety. The name *polyglochin,* however, was already used for all *Brachydactylae* (1882, p. 13; NORDSTEDT, 1889, p. 7).

N. Roxburghii, published in 1849, seems to be identic (cf. GROVES, 1924, p. 368) with BRUZELIUS's *Chara furcata* published in 1824 and was already transferred in the same year to the genus *Nitella* by AGARDH. Therefore the name *furcata* is valid for the collective species.

With regard to the name *Chara furcata* HORNEMANN, to be found on several herbarium labels, it must be remarked that this is a synonym

to *C. corallina*. BRAUN published in 1835 a species under the name of *Chara Roxburghii*; as I did not see specimens, I cannot decide with certainty from the description alone what species is meant here.

Ecology. *N. furcata* is especially common in streams, rivers little ponds, rice-fields and moats. It is most probably very susceptible to the environmental conditions, as the habit of the plant is extremely variable.

According to GROVES (1927, p. 338) and G. O. ALLEN (1928, p. 59) this species occurs in India plentifully during the rains from September to January. From July to September, and, moreover, in February and March (cf. var. *Roxburghii*) plants with ripe oospores were collected in the Netherlands Indies.

To the Java specimens of var. *Zollingeri* collected by the German Limnol. Sunda Exped. the following notes are added: temperature 25°—33° C; pH 6.5; conductivity $0.23 . 10^{-4}$. The Java specimen belonging to the same variety from herb. VAN DEN BOSCH, was collected together with *N. acuminata*.

Distribution. Between 30° N. and 36° S.; ASIA, India: Coromandelia; Pegu; Nicobar Islands; Malaysia: Malay Peninsula, Java, Borneo, Celebes; Soembawa; Philippine Islands; cf. varieties. Moreover in lit.: India: Malabaria, Kashmir, MUKERJI (1934, p. 295); Salsette, DIXIT (1935, p. 257); Ceylon, cf. var. *Roxb.*; Bengal, ROXBURGH (1832, p. 564); AGHARKAR & KUNDU (1937, p. 9); Gangetic Plain, Saharanpore, GROVES (1927, p. 338), ALLEN (1928, p. 58); Serampore, GRIFFITH (1849, p. 281); Burma, PAL (1932, p. 78); Malay Peninsula, GROVES (1924, p. 367) — AMERICA, ? N. Am., ex GROVES & ALLEN (1937, p. 48); S. Am., Uruguay, ALLEN & HERTER (1934, p. 88) — AFRICA, S. Afr.: Rhodesia, Uganda in herb. (K), according to a letter of Mr G. O. ALLEN; Madagascar, GROVES (1928, p. 133) — AUSTRALIA, Queensland, GROVES & ALLEN (1937, p. 48).

var. α **Roxburghii** (A. BRAUN) ZANEV., nov. comb. — *Nitella Roxburghii* A. BRAUN in HOOKER's Journ. Bot. 1, 1849, p. 293 (non *Chara Roxburghii* A. BR., 1835); id. in Monatsb. Kön. Akad. Wiss. Berlin f. 1867, p. 816, note 1, 1868 (*nom. tant.*); H. & J. GROVES in Philipp. Journ. Sci. 7, 1912, p. 69; J. GROVES in Journ. Linn. Soc., Bot., 46, 1922, p. 101 — *Nitella polyglochin* A. BR. var. *Roxburghii* A. BR. in Abh. Kön. Akad. Wiss. Berlin, 1882, pp. 13, 73; T. F. ALLEN, Charac. America 1, 1888, p. 47 (*nom. tant.*) — *Nitella polyglochin* A. BR. f. ? ap. BAILEY, Compreh. Catal. Queensl. Pl., 1909, p. 678; NORDSTEDT in Proc. Roy. Soc. Viet. 31, N. S., 1918, p. 3 (*nom.*

tant.) — ? *Nitella polyglochin* A. BR. f. *japonica* MIGULA in Hedwigia 70, 1930, p. 213.

Illustrations. BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, pl. 5, figs. 140—144.

Plant stout, up to 30 cm high. *Stem* up to 1100 μ in diam. *Sterile branchlets* 1—2 times furcate, spreading. *Fertile branchlets* thrice furcate, compact. *Oospores* 270—310 μ long.

INDIA: Coromandelia, Madras, no date, WIGHT s.n., herb. HOOKER in (B), fragments of the *type*; Pegu, Kya Eng, 28 XII 1870, KURZ 3295 (B).

MALAY PENINSULA: Kedah, Pulo-Langkawi, in stream, 27 VIII 1925, HOLTTUM, St. of Kedah 17345 (Si).

PHILIPPINE ISLANDS: Luzon, Prov. of Ilocos Norte, Bangui, II—III 1917, RAMOS, Fl. of Philipp. 27465 (K).

Remarks. The Madras specimens of Dr WIGHT, which I saw from the Berlin herbarium, were most probably only fragments of the type of *N. Roxburghii*. This species was described in 1849 by BRAUN, as being of "considerable size", whereas the plants seen by me were only small fragments and unnumbered.

Distribution. Between 20° N. and 5° N.; ASIA, India: Coromandelia; Pegu; Malay Peninsula; Philippine Islands. Moreover in lit.: Ceylon, GROVES (1922, p. 101).

var. β **Zollingeri** (A. BRAUN) ZANEV., nov. comb. — *Nitella polyglochin* A. BR. var. *Zollingeri* A. BRAUN in G. VON MARTENS, Die Preuss. Exp. n. O.-As., Bot. Th., 1866, p. 143 (*nom. tant.*); BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, pp. 13, 74; T. F. ALLEN, Charac. America 1, 1888, p. 47 (*nom. tant.*); NORDSTEDT in Act. Univ. Lund. 25, 1889, p. 27 (?); DE WILDEMAN, Prodr. Fl. Alg. Ind. Néerl., 1897, p. 31; id., Suppl. et Tabl. Stat., 1899, p. 89; id., Alg. Fl. Buitenz., 1900, p. 376 — *Nitella polyglochin* A. BR. f. *javanica* FILARSZKY in Arch. Hydrobiol. 1934, Suppl. Bd. 12, Trop. Binnengew. Bd. 4, p. 711.

Illustrations. BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, pl. 5, figs. 145—146; DE WILDEMAN, Alg. Fl. Buitenz., 1900, f. 141; FILARSZKY in Arch. Hydrobiol. 1934, Suppl. Bd. 12, Trop. Binnengew. Bd. 4, figs. 17—26.

Plant rather stout, up to 20 cm high. *Stem* 400—850 μ in diam. *Sterile* and *fertile branchlets* 3—4 times furcate, more or less similar. *Oospores* 225—265 μ long.

JAVA: Batavia, Batavia, III, no year, no collector's name, ex herb. VAN DEN BOSCH in (B, L); Buitenzorg, Buitenzorg, little pond at right border of river Tjiliwoeng, 20 IX 1928, German Limnol, Sunda Exped. B2d γ (Bu-Mus), *type* of *N. polyglochin* f. *javanica* FILARSZKY.

BORNEO: W. Division, Bengkajang[1]), in rice-fields and in moats, 22 III 1863, VON MARTENS 4 (B).

CELEBES: Celebes & Depend., near Makassar, in the river near Maros, 1 VII 1861, Prussian Exped. to East Asia, WICHURA 2072 (B).

SOEMBAWA: Najadea, in the river Oetan, VIII 1847, ZOLLINGER 3386 (B, *type* of *N. polyglochin* A. BR. var. *Zollingeri* A. BR.; L).

Remarks. The type of this variety collected in Soembawa was mentioned in BRAUN & NORDSTEDT (1882, p. 74) as sterile; closer examination, however, proved it to be fertile though immature. The same is the matter with the Java specimen in herb. VAN DEN BOSCH, which has ripe oospores too. BRAUN's figures 145 and 146 of the dactyls with the globular inferior cells are drawn after these plants. This character is not found in the other plants, and it is therefore not to be used for the variety.

Distribution. Between 1° N. and 20° S.; ASIA, Malaysia: Java, Borneo, Celebes, Soembawa. Moreover in lit.: AUSTRALIA, Queensland, NORDSTEDT (1889, p. 27, ?).

var. γ **nicobarica** (A. BRAUN) ZANEV., nov. comb. — *Nitella polyglochin* A. BR. var. *nicobarica* A. BRAUN in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 13; T. F. ALLEN, Charac. America 1, 1888, p. 47 — *Nitella polyglochin* A. BR. var. *Zollingeri* A. BR. f. *nicobarica* A. BR. in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 75; NORDSTEDT in Act. Univ. Lund. 25, 1889, p. 12.

Plant slender, up to 15 cm high. *Stem* 500—600 μ in diam. *Sterile branchlets* twice furcate, spreading. *Fertile branchlets* thrice furcate, compact. *Oospores* 180—220 μ long.

NICOBAR ISLANDS: without exact locality and date, ex herb. Hort. Bot. Hafn. 1854, DIDRICHSEN, Galathea exped. 2732 (B).

Remarks. The smallest of the three varieties. The branchlet-whorls are less compact and the internodes very long, up to 4 cm.

Distribution. 7° N.; ASIA, Nicobar Islands.

2. Series HETEROCELLULATAE ZANEV., nov. ser.

Articulationes ramulorum ultimae (dactyli) bi — tri-cellulatae.

Dactyls (ultimate rays of the branchlets) indifferently 2—3-celled.

Remarks. It seems desirable to unite the plants, which are intermediate between the *Bicellulatae* and *Pluricellulatae*, into a separate series: *Heterocellulatae*, just as the transitional plants between the subsections of the *Anarthrodactylae* and *Arthrodactylae* are placed in the subsection *Heterodactylae*.

[1]) Published in the "Fragmente" (1882, p. 74) as "Barkajang".

23. Nitella superba PAL in Journ. Linn. Soc., Bot., 49, 1932, pp. 64, 67, pl. 8; J. GROVES in Journ. Linn. Soc., Bot., 46, 1924, pp. 362, 369 (as *Nitella* sp. *N. myriotricha* KUETZ. prox.); KUNDU in Journ. Ind. Bot. Soc. 16, 1937, p. 267.

Plant dioecious, stout. *Internodes* of the male plant 1—3 times, of the female plant 2—5 times the length of the branchlets. *Sterile* and *fertile branchlets* ± similar, 5—6 in a whorl, in the male plant 2—4 times, in the female plant 3 times furcate; secondary rays 6. *Dactyls* 3—4, two- and three-celled. Fertile whorls forming heads enveloped in dense mucus. *Antheridia* solitary, at the first and second branchlet-nodes, 450 μ in diam. *Oogonia* solitary, at the lower three branchlet-nodes, 300—350 μ long (incl. coronula), showing 8—9 convolutions of the spiral-cells; *oospores* not described.

Remarks. Closely allied to *Nitella myriotricha*, differing only in the size of the oogonia. The female plant is much more infested with mucus than the male plant. No specimens examined.

Ecology. Unknown.

DISTRIBUTION. Between 26° N. and c. 12° N.; ASIA, India: Malabaria, Assam, Burma.

24. Nitella mucronata [1]) (A. BRAUN) MIQUEL in VAN HALL, Flor. Belg. septentr. 2, 1840, p. 428; KUETZING, Phyc. Germ., 1845, p. 256; id., Spec. Alg., 1849, p. 514; id., Tab. Phyc. 7, 1857, p. 13; BRAUN in N. Denkschr. Schweiz. Ges. Naturw. 10, 1849, p. 9; WALLMAN in Act. Soc. Linn. Bordeaux 21, 1856, p. 22; BRAUN in Monatsb. Kön. Akad. Wiss. Berlin f. 1867, p. 810, 1868; BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, pp. 11, 50; T. F. ALLEN, Charac. Americ. 1, 1888, p. 45 (*nom. tant.*); NORDSTEDT in Act. Univ. Lund. 25, 1889, p. 9; T. F. ALLEN in Torrey Bot. Cl. 21, 1894, p. 524; id., Charac. America 2, 3, 1896, pp. 19, 20; GROVES & BULLOCK WEBSTER, Brit. Charoph. 1, 1920, pp. 92, 113; J. GROVES in Journ. Linn. Soc., Bot., 46, 1922, p. 98; id. in Journ. Linn. Soc., Bot., 46, 1924, pp. 361, 366; G. O. ALLEN in Journ. Bombay Nat. Hist. Soc. 30, 1925, p. 597; id. in Journ. Ind. Bot. Soc. 7, 1928, p. 56; J. GROVES in Journ. Linn. Soc., Bot., 48, 1928, p. 127 (var. *mobilis*); PAL in Journ. Burma Res. Soc. 18, 1929, p. 113 (*nom. tant.*); MIGULA in Hedwigia 70, 1930, p. 212; PAL in Journ. Linn. Soc., Bot., 49, 1932, pp. 64, 71; STROEDE, Oekol. d. Charac., 1931, p. 26; MUKERJI in Proc. 21st Ind. Sci. Congr., Bombay, 1934, p. 295; ALLEN & HERTER in Rev. Sudameric. 1, Bot. 1, 1934, p. 88 (var. *leiopyrena*); DIXIT in Journ. Ind. Bot. Soc. 14, 1935, p. 257; AGHARKAR & KUNDU in Journ. Dep. Sci., N. S., 1, 1937, pp. 3, 6; HASSLOW in Bot. Not., Lund, 1939, p. 295; ZANEVELD, in Blumea 3,

[1]) The European literature is to be found in MIGULA (1897, p. 149) and in GROVES & BULLOCK WEBSTER (1920, pp. 113—114).

1939, pp. 379, 382 (var. *mobilis*) — *Chara mucronata* A. BRAUN in Ann. Sci. Nat., Bot., 2, 1834, p. 35; id. in Flora 18, 1835, p. 52 — *Nitella flabellata* KUETZING, Phyc. Gen., 1843, p. 318; id., Phyc. Germ. 1845, p. 256 (var. *tenuior*) — *Nitella exilis* A. BRAUN in N. Denkschr. Schweiz. Ges. Naturw. 10, 1849, p. 9; KUETZING, Spec. Alg., 1849, p. 515; id., Tab. Phyc. 7, 1857, p. 13 — *Nitella pseudograciliformis*, cf. variety.

Illustrations. KUETZING, Tab. Phyc. 7, 1857, pl. 33; NORDSTEDT in Act. Univ. Lund. 25, 1889, f. 18; T. F. ALLEN, Charac. America 2, 3, 1896, unnumbered pl.; MIGULA, Die Charac., 1897, figs. 42—44; id., Syn. Charac. europ., 1898, figs. 30—32; GROVES & BULLOCK WEBSTER, Brit. Charoph. 1, 1920, pl. 1 & 12; G. O. ALLEN in Journ. Ind. Bot. Soc. 7, 1928, f. 5; GROVES in Journ. Linn. Soc., Bot., 1928, pl. 5, figs. 7—8, pl. 7, f. 5; AGHARKAR & KUNDU in Journ. Dep. Sci., N. S. 1, 1937, pl. 3, figs. 6—14.

Plant monoecious, dark to brownish green, up to 30 cm high, more or less covered with clay. *Stem* moderately stout, 430—680 μ in diam. *Internodes* 1—2 times the length of the branchlets. *Sterile branchlets* more or less similar to the fertile ones, but the latter more compact; both 5—6 in a whorl, 2—3 times furcate (the fertile branchlets usually only 3 times); primary rays up to $^2/_3$ as long as the entire branchlet; secondary rays 4—5 (—6); tertiary rays 2—4 (—5); quaternary rays (dactyls) 2—3 (—4). *Dactyls* 2—3, usually two-celled, rarely three-celled, inferior cell rounded at the apex, ultimate cell much narrower, conical, acute, forming a mucro. ♂ and ♀ *gametangia* at all free nodes, not surrounded by a mucus cloud. *Antheridia* solitary, 240—310 μ in diam. *Oogonia* solitary or seldom geminate, 430—625 μ long (incl. coronula), 320—400 μ wide; *spiral-cells* showing 7—9 convolutions; *coronula* 32—55 μ high, c. 80 μ wide at base, persistent, interstices below the coronula for the admission of the spermatozoids distinctly visible; *oospores* dark-brown to almost black, 256—350 μ long, 234—300 μ wide, with 6—7 thin ridges; *outer membrane* translucent, reticulate.

JAVA: C. Priangan, Tjihandjawar near Poerwakarta, in rice-fields, 650 m alt., 22 VII 1920, BAKHUIZEN VAN DEN BRINK 4279 (Bz).

Remarks. The specimen cited above is very poor and badly preserved and therefore I can only refer it to this species in a broader sense. *N. mucronata* is a very variable species and the number of varieties and subspecies distinguished is high, most probably on account of the fact that the habit of this plastic species is to a high degree susceptible to environmental conditions. A review of the variability is

very well given by MIGULA (1897), who states that the only varieties worth while to be distinguished are BRAUN's ssp. *Wahlbergiana* from Scandinavia and *virgata* from Europe, Asia, N. Africa and N. America. These are characterized, the first by the short secondary rays and the much contracted fertile whorls, and the latter by the frequently three-celled dactyls, the geminate oogonia, and the yellow-brown oospore membrane.

Afterwards GROVES & BULLOCK WEBSTER (1924, p. 117) distinguished a variety *gracillima* from Great Britain especially on account of the penultimate dactylous cell tapering gradually to the apex, so that the apex is not much broader than the base of the apical cell. In 1928 (p. 127) GROVES again described a new var. *mobilis*, collected in Madagascar and characterized by the wide variation in the length and shape of the ultimate cell of the dactyl. It is, however, questionable whether these last two varieties have reasonable ground for existence.

Nitella mucronata is very much relied to *N. pseudoflabellata*, which has more rays at the second and ultimate furcations and the primary ray always longer than half the length of the entire branchlet. The new variety forms a transition between these two species.

Ecology. *Nitella mucronata* is a dark-green coloured plant of medium size, usually much infested with epiphytes and clay and sometimes incrusted with lime. It occurs in shallow water of ponds and rice-fields, in India in the earlier part of the cold season, i. e. from October to April. The bottom of the ponds in which it grows consists of soft mud, containing sometimes 40.4 % organic substances (STROEDE, 1931, p. 26).

It is found growing together with *Nitella acuminata, N. flexilis, Chara fibrosa* ssp. *gymnopitys, C. globularis,* and the Phanerogams: *Potamogeton crispus, Najas minor,* and *Hydrilla verticillata.*

Distribution: Between 42° N. and 35° S.; ASIA, Malaysia: Java, Bali, cf. variety. Moreover in lit.: EUROPE, cf. MIGULA (1897, p. 158) and GROVES & BULLOCK WEBSTER (1920, p. 116) — ASIA, Songaria, RUPRECHT (1845, p. 10), BRAUN & NORDSTEDT (1882, p. 52); Japan, T. F. ALLEN (1894, p. 524), MIGULA (1930, p. 212); India: W. Himalaya, MUKERJI (1934, p. 295); Malabaria, GROVES (1924, p. 266), Pashan, DIXIT (1935, p. 257); Ceylon, GROVES (1922, p. 98); Gangetic Plain, Saharanpur, ALLEN (1928, p. 56), Gonda, GROVES (1924, p. 366), ALLEN (1925, p. 597), Benares, GROVES (1924, p. 366), Sonarpur, AGHARKAR & KUNDU (1937, p. 6); Burma, GROVES (1924, p. 366), PAL (1934, p. 71) — AMERICA, N. Am.: New Hampshire, Masachusetts,

Virginia, BRAUN & NORDSTEDT (1882, pp. 51, 52, 53); N. Carolina, T. F. ALLEN (1896, p. 21); Texas; C. Am.: Mexico, BRAUN & NORDSTEDT (1882, pp. 53, 54); S. Am.: Uruguay, ALLEN & HERTER (1934, p. 88) — AFRICA, N. Afr.: Algeria, BRAUN (1868, p. 812); Egypt, Abyssinia, BRAUN & NORDSTEDT (1882, p. 52); S. Afr.: Cape Colony, BRAUN (1868, p. 812); Madagascar, GROVES (1928, p. 127).

var. α **pseudograciliformis** (FILARSZKY) ZANEV., nov. comb. — *Nitella pseudograciliformis* FILARSZKY in Arch. Hydrobiol. 1934, Suppl. Bd. 12, Trop. Binnengew., Bd. 4, p. 707; id. in Math. u. Naturw. Anz. Ung. Akad. Wiss. 52, 1935, p. 468 (*nom. tant.*); J. GROVES in Journ. Bot. 73, 1935, p. 48 (*nom. tant.*).

Illustrations. FILARSZKY, *l. c.* 1934, figs. 3—9; the pres. paper, figs. 6*a*—*b*.

Plants slender, flexible, elongate. *Stem* c. 500 μ in diam. *Internodes* 2—3 times the length of the entire branchlets. *Sterile branchlets* 6 in a whorl, c. 2 cm long, 2—3 times furcate; *fertile branchlets* 6—7 in a whorl, c. 1.5 cm long, more compact, 3 times furcate; in both kinds of branchlets 5—6 secondary rays, 2—5 tertiary rays, 2—4 quaternary rays. *Dactyls* 2—4, usually two-celled, occasionally three-celled; inferior cell in the sterile branchlets up to 2 mm long and c. 60 μ wide, in the fertile branchlets up to 1.5 mm long and c. 50 μ wide; ultimate cell of both 60—90 μ long, c. 45 μ wide at base. *Antheridia* terminal, c. 290 μ in diam. *Oogonia* lateral, in a very young state always two together, when older solitary; mature oogonia (only 3 extant) 623 μ long (coronula incl.), 400 μ wide; *spiral-cells* showing 8—9 convolutions; *coronula* 53 μ high, c. 80 μ wide at base; interstices distinctly visible; *oospore* very dark-brown to purplish black, 312 μ long, 267 μ wide, with 6—7 ridges.

BALI: Danaubratan, little caldera lake near Batoeriti, alt. 1231 m, German Limnol. Sunda Exped. BB2a (Bu-Mus), *type* of *N. pseudograciliformis* F.

Remarks. In the base of the sterile and fertile whorls of the specimens cited, frequently one or two short, and once or twice furcate fertile branchlets occur. This is often the case in this species, cf. GROVES & BULLOCK WEBSTER, pl. 1 and 12 (1920). However, the type specimen shows in only one whorl between two normal branchlets, 4 of these short, once-furcate fertile branchlets, originating from the same nodal cell; 3 of these bear at the first furcation one antheridium (terminal), one oogonium (lateral), and one ray; at the ultimate node of this secondary ray again one terminal antheridium, but two lateral oogonia are found. The primary ray of the fourth branchlet

is furcate into 3 secondary rays, each bearing at the ultimate node one antheridium and two oogonia (cf. f. 6*a*).

The occurrence of these short branchlets at this node was most probably the reason, why FILARSZKY described the plants as belonging to the "*Heterophyllae*" (= *Heteroclemae*). It is obvious, that this is not the case, and that these branchlets belong to an accessory shoot of which the internodal cell is not developed. FILARSZKY's figures 3 and 5 are imperfect. The whole plant is somewhat aberrant, as antheridia and oogonia are to be found at every place where a branchlet is dropped. Moreover, the oogonia often have but four spiral-cells, cf. f. 6*b*.

I have given an emendation of the description of FILARSZKY showing that his species is identic with *N. mucronata*, although having some characters of *N. pseudoflabellata*. It differs from the latter in having geminate oogonia, and from the normal forms of the former in the somewhat higher number of rays at the various furcations of the branchlets, and is therefore separated as a variety thereof.

Ecology. On the label of the badly preserved specimens the following notes are added: temperature of the surface 22°.1 C., pH 6.8, alkalinity 0.16; diam. of the caldera lake c. 2.6 km, total depth 22 m. It was found growing at a depth of 10 m together with *Chara fulgens*.

Distribution. On 8°30′ S.; ASIA, Malaysia: Bali.

25. Nitella tenuissima (DESVAUX) KUETZING var. *α* **byssoides** A. BRAUN in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 64; J. GROVES in Journ. Linn. Soc., Bot., 46, 1924, pp. 362, 367 — *Nitella byssoides* A. BRAUN in HOOKER's Journ. Bot. 1, 1849, p. 294; WALLMAN in Act. Soc. Linn. Bordeaux 21, 1856, p. 23.

Plant monoecious, extremely minute. *Internodes* 2—5 times the length of the branchlets. *Sterile* and *fertile* branchlets similar, 6 in a whorl, twice furcate; secondary rays 6—7. *Dactyls* 3—4, invariably two- and three-celled. ♂ and ♀ *gametangia* together at the second and third branchlet-nodes, lacking at the first node and at the base of the whorls, solitary, not enveloped in mucus. *Antheridia* c. 175 *μ* in diam. *Oospores* yellowish brown, 190 *μ* long, with 6—7 ridges. *Membrane* with beaded reticulation.

Remarks. The species has much resemblance with *Nitella mucronata*, *N. gracilis* and *N. batrachosperma*, but is at once distinguished by the sterile first branchlet-node. The variety is only once collected on the coast of Coromandel and this is, moreover, the only record of the species from Asia. Otherwise the species is very common in Europe, and is also known from N. America, the West Indies and from N. and S. Africa, Madagascar incl.. No Malaysian specimens examined.

Ecology. In Great Britain the species is restricted to fenlands only.

Distribution. On c. 15° N.; ASIA, India: Coromandelia.

26. Nitella elegans PAL in Journ. Linn. Soc., Bot., 49, 1932, pp. 64, 73, pl. 11.

Plant monoecious, extremely slender, up to 15 cm high. *Internodes* 2—4 times the length of the branchlets. *Sterile branchlets* lax, 8 in a whorl, 3—4 times furcate; secondary rays 8. *Fertile branchlets* similar, but smaller and enveloped in mucus. *Dactyls* 3, two- and sometimes three-celled. ♂ and ♀ *gametangia* together at the second and third branchlet-nodes, and occasionally at the first and uppermost ones, solitary. *Antheridia* 175—210 μ in diam. *Oospores* reddish to dark-brown, 220 μ long, with 7—8 ridges. *Membrane* not described.

Remarks. The most striking peculiarity of this species is the production of a fertile branchlet in the axils of the first furcation of the branchlets of the upper whorls. No specimens examined.

Ecology. In a pond at short distances from each other, apparently preferring solitary to gregarious growth, though there was plenty of room and little competition offered by other plants.

Distribution: 22° N.; ASIA, India: Burma.

27. Nitella polycarpa PAL in Journ. Linn. Soc., Bot., 49, 1932, pp. 65, 77, pl. 13.

Plant monoecious, fairly tall. *Internodes* 2—3 times the length of the branchlets. *Sterile* and *fertile branchlets* similar, 6 in a whorl, 3—5 times furcate, secondary rays 2—4. *Dactyls* 2—3, two-, occasionally three-celled. ♂ and ♀ *gametangia* together at all branchlet-nodes, oogonia also at the base of the whorls, aggregated, not enveloped in mucus. *Antheridia* 275 μ in diam. *Oospores* light-brown, 260 μ long, with 6—7 ridges. *Membrane* finely nodose-reticulate.

Remarks. Readily distinguished from the nearly allied *Nitella microcarpa* and *N. furcata* by the occasional presence of a three-celled dactyl, and by the whorls being sterile. No specimens examined.

Ecology. In shallow water together with a large number of other plants, such as *Marsilia, Azolla,* and *Cyanophyceae.*

Distribution. 18° N.; ASIA, India: Burma.

28. Nitella microcarpa A. BRAUN in Monatsber. Kön. Akad. Wiss. Berlin, 1858, p. 357; NORDSTEDT in Hedwigia 27, 1888, p. 183; BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, pp. 13, 71; T. F. ALLEN, Charac. America 1, 1888, p. 47 (*nom. tant.*); NORDSTEDT in Acta Univ. Lund. 25, 1889, p. 11; H. & J. GROVES in URBAN, Symb. Antill. 7, 1911, pp. 30, 36; NORDSTEDT in Proc. Roy. Soc. Victoria, N. S. 31, 1918, p. 3 (*nom. tant.*); RIDLEY in Journ. Straits Branch R. A. Soc. 80, 1919, p. 163; J. GROVES in Journ. Linn. Soc., Bot., 46, 1922, p. 101; id. in Journ. Linn. Soc., Bot., 46, 1924, pp. 362, 368; MUKERJI in Proc. 21st Ind. Sci. Congr., Bombay, 1934, p. 295; GROVES & ALLEN in Proc. Roy. Soc. Queensl. 46, 1935, pp. 41, 47 — *Nitella Glaziovii*; *Nitella microcarpa* f. *santosa,* f. *santosa-tenuior,* ssp. *Glaziovii*; *Nitella microglochin*; *Nitella polyglochin*; *Chara timorensis*; cf. varieties.

Illustrations. BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, pl. 2, figs. 56—57; pl. 3, fig. 78.

Plant monoecious, dark-brownish green, up to 25 cm high. *Stem* moderately slender to stout, 500—1100 μ in diam. *Upper internodes* half to as long as the length of the branchlets; *lower internodes* usually somewhat longer. *Sterile branchlets* 6 in a whorl, up to 4 cm long, 2—3 times furcate, much spreading; primary rays half as long as the entire branchlet, sometimes longer; secondary rays 4—6; tertiary rays 2—4, of which usually 1—3 are again furcate into 1—3 quaternary rays. *Fertile branchlets* 6 in a whorl, 1.5—2 cm long, 3—4 times furcate, much condensed; primary rays $^1/_3$—$^1/_2$ the length of the entire branchlet; secondary rays 4—6; tertiary rays 3—5, of which 1—2 are again forked into 2—3 quaternary rays; quinary rays, if any, 1—3. *Dactyls* 1—3, usually two-celled, but often three-celled dactyls are also extant especially in the sterile branchlets; inferior cell varying in length, up to 1000 μ long and 55—120 μ wide, ultimate cell conical, 60—150 μ long, 20—90 μ wide at base. ♂ and ♀ *gametangia* frequently at all and the same nodes, however, when the dactyls are very short, the ultimate node usually sterile (cf. var. *microglochin*), the base of the branchlet-whorls always so, not enveloped in mucus. *Antheridia* sessile, solitary, terminal, 180—290 μ (— 400 μ, var. *megacarpa*) in diam. *Oogonia* sessile, lateral, frequently 2—4 (sometimes more) together around one antheridium; 250—530 μ long (incl. coronula), 210—415 μ wide; *spiral-cells* showing 7—8 convolutions; *coronula* 30—80 μ high, 45—100 μ wide at base, persistent, both rows of cells equal in length; *oospores* golden-brown, 180—450 μ long, 225—450 μ wide, with 6 sharp ridges; *outer membrane* reticulate.

Remarks. Owing to the extremely variable length of the dactyls, the brachydactylous group has a large number of species, which are very closely allied to each other. A ready means of identifying *Nitella microcarpa* is provided by the short coronula, the clustered oogonia (lacking at the base of the whorls), and the variable length of the dactyls. By these characters it is distinguished from *N. oligospira, N. furcata,* and *N. polycarpa,* whereas *N. burmanica* has strictly two-celled dactyls. *N. orientalis,* finally, has the oospore membrane granulate, whereas it is reticulate in the other brachydactylous species.

The sizes of the oospores and the variable length of the dactyls are features, important enough for some authors to base new species upon, viz. *N. microglochin, Glaziovii,* and *megacarpa.* In this connection I have to state that I could study the type of *N. microglochin* extant in the Berlin herbarium. Obviously the type has

aggregate oogonia and not solitary ones, as was accepted formerly. The dactyls are for the greater part all very short, since the inferior cell of the dactyls is sub-quadratic. Therefore, I consider it a variety of *N. microcarpa*.

In the type of *N. microcarpa* collected in Paramaribo (Netherlands Guyana) and extant in (B), there are but very few abbreviated dactyls as is clearly visible in BRAUN's fig. 78 on pl. 3 (1882), and, moreover, many of the dactyls are three-celled. In my opinion, these plants and the other ones mentioned by BRAUN (1858, p. 357) must be included in his var. *Drummondii* described in 1882 (p. 72); the length of the ripe oospores vary from 180—240 μ.

In the "Fragmente" two other subspecies of *N. microcarpa* are distinguished, viz. *Glaziovii* with oospores of 240—280 μ length, and *megacarpa* in which they are 370—450 μ. Afterwards two more new varieties were distinguished, viz. *natalensis* by SYDOW from Natal (MIGULA, SYDOW and WAHLSTEDT, Charac. exsicc.), and var. *Wrightii* by H. & J. GROVES (1911, p. 37) from Cuba (W. Indies), which most probably have to be combined with one of the four varieties cited above; without having seen the types I have to refrain from a decision.

The plants from the Indian and Malaysian areas known at present, appear to belong to the varieties *microglochin* and *Glaziovii* only, and to a new var. *papuana*.

Ecology. Cf. the varieties.

Distribution. Between 45° N. and 35° S.; ASIA, India: Pegu; Malaysia: Malay Peninsula, Perak, Penang; Sumatra, Java, Borneo, Celebes, Timor, New Guinea, cf. varieties. Moreover in lit.: ?China, ?Japan, ex GROVES & ALLEN (1937, p. 48); India: W. Himalaya, MUKERJI (1934, p. 295); Bengal, AGHARKAR & KUNDU (1937, p. 8); Burma, PAL (1932, p. 76); Ceylon, GROVES (1922, p. 101) — AMERICA, N. Am.: Canada, Louisiana, BRAUN & NORDSTEDT (1882, p. 71, 72, var. *Drummondii*); Michigan, Massachusetts, T. F. ALLEN (in Charac. exsicc.); C. Am.: Cuba, NORDSTEDT (1888, p. 183); GROVES (1911, p. 36, p. 37, var. *Wrightii*), Abarca, Jamaica, Guadeloupe, GROVES (1911, p. 36); Panama, BRAUN (1858, p. 367); S. Am.: Netherlands Guyana, BRAUN (1858, p. 367), Brazil, cf. var. *Glaziovii* — AFRICA, S. Afr.: Cape Colony, cf. var. *Glaziovii*; Natal, in herb. (L); ??Madagascar[1]), ex GROVES (1924, p. 368) — AUSTRALIA, Queensland, GROVES & ALLEN (1937, p. 47).

[1]) This locality is not to be found elsewhere in the literature, and as it is not cited in GROVES' article on the Madagascar *Charophyta* (1928) either, it is dubious.

var. α **microglochin** (A. BRAUN) ZANEV., nov. comb. — *Nitella microglochin* A. BRAUN in ZELLER, Journ. Asiat. Soc. Bengal 42, 1873, p. 193 (*nom. tant.*); BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, pp. 13, 71; T. F. ALLEN, Charac. America 1, 1888, p. 47 (*nom. tant.*); NORDSTEDT in Act. Univers. Lund. 25, 1889, p. 11; J. GROVES in Journ. Linn. Soc., Bot., 46, 1924, pp. 362, 368; PAL in Journ. Burma Res. Soc. 18, 1929, p. 113 (*nom. tant.*); id., in Journ. Linn. Soc., Bot., 49, 1932, pp. 65, 75 — *Chara timorensis* ZIPPELIUS in Herb. Lugd. Bat. — *Nitella polygochin* A. BR. sens. lat. ap. NORDSTEDT in Forsch. Reise S. M. S. "Gazelle", 4 Th. Bot., 1889, p. 7.

Plant rather slender. *Stem* up to 600 μ in diam. *Dactyls* frequently all extremely short, usually two-celled, only occasionally three-celled; inferior cell nearly as long as broad, 35—110 μ long, 40—85 μ wide, ultimate cell conical, slightly curved, 60—70 μ long, 20—40 μ at base. ♂ and ♀ *gametangia* frequently lacking at the ultimate branchlet-node. *Oogonium* c. 310 μ long (incl. coronula), 290 μ wide; *oospore* 180—240 μ long, 225—260 μ wide.

INDIA: Pegu, Arakan (formerly published as "Arracan"), Kolodyne Valley, in a jungle swamp, X 1869, KURZ s.n. (B), *type* of *N. microglochin* A. BR.

MALAY PENINSULA: Perak, Gunong Tungal, Dindings, in muddy water on a path in jungle, III 1896, RIDLEY, St. of Perak 7142, (K, Si); ibid., Dindings, II 1897, RIDLEY, St. of Perak s.n., (Si); ibid., Sungei Siput, in a stream, 11 IX 1920, BURKILL, St. of Perak 6331 (Si); Penang, without exact locality, waterface in pond, VII 1889, CURTIS, Fl. of Penang 1887 (Si).

CELEBES: Pangkadjene, no date, TEYSMANN 11930 (Bz).

TIMOR: without exact locality, no date[1]), ZIPPELIUS s.n. (Bz); S. Timor, Koepang, 15 V 1875, NAUMANN 337 and 338 (B); ibid., Pariti, 22 V 1875, NAUMANN 6 (B); both specimens immature, therefore identification uncertain.

Remarks. This variety was formerly distinguished as a species from *N. microcarpa* on account of the "solitary" oogonia. Re-examination of the type, however, showed that the oogonia were clustered and situated around one antheridium.

The size of the oospores and the sub-quadratic inferior cells of the dactyls may serve to discriminate this variety from var. *Glaziovii* and *papuana*.

Ecology. In jungle swamps and in ponds. It seems that a muddy bottom is preferred, as the plants are densely covered with clay. Specimens with ripe oospores as far as known from our area have been collected in July, October and February. According to PAL (1932, p. 86), the seasonal distribution in Burma is restricted to

[1]) ZIPPELIUS collected here in 1828.

October and November. The plants are overgrown with epiphytes.

RIDLEY (1919, p. 163) remarks to his plants from the Gunong Tungal, Dindings, that he found the footprint of a rhinoceros in the middle of the jungle, where water had gathered, quite full of specimens of a *Nitella* species, the oospores having probably been transported in mud by the rhinoceros from some distance. This illustrates very well the capricious dispersion of *Charophyta*.

Distribution. Between 20° N. and 10° S.; ASIA, India: Pegu; Malaysia: Malay Peninsula, Celebes, Timor. Moreover in lit.: Burma, PAL (1932, p. 76).

var. *β* **Glaziovii** (ZELLER) ZANEV., nov. comb. — *Nitella Glaziovii* ZELLER ap. WARMING in Vidensk. Meddel. naturh. For. Kjoebenh., 1876, p. 428; NORDSTEDT in Act. Univ. Lund. 25, 1889, p. 11; AGHARKAR & KUNDU in Journ. Dep. Sci., N. S. 1, 1937, pp. 3, 8 — *Nitella microcarpa* A. BR. ssp. *Glaziovii* (ZELLER) NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 72; T. F. ALLEN, Charac. America 1, 1888, p. 47 (*nom. tant.*); NORDSTEDT in Act. Univ. Lund. 25, 1889, p. 27 — *Nitella microcarpa* A. BR. ssp. *Glaziovii* (ZELLER) NORDSTEDT f. *santosa* NORDSTEDT and f. *santosa-tenuior* NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 73.

Illustrations. NORDSTEDT in Act. Univ. Lund., 1889, f. 27; AGHARKAR & KUNDU in Journ. Dep. Sci., N. S. 1, 1937, pl. 4, figs. 1—9.

Plant stout. *Stem* up to 1100 *μ* in diam. *Dactyls* varying much in length, frequently one or two much longer than the other one(s); sometimes all much elongate or abbreviated, two- and occasionally three-celled; inferior cell up to 1000 *μ* long, and 120 *μ* wide, ultimate cell conical, up to 150 *μ* long, and 90 *μ* wide. ♂ and ♀ *gametangia* only extant at the ultimate branchlet-node, if one or more of the dactyls are elongated. *Oogonia* 415—475 *μ* long (incl. coronula), 300—325 *μ* wide; *oospores* 240—280 *μ* long, 220—250 *μ* wide.

MALAY PENINSULA: Perak, Bruas, Dindings, III 1896, RIDLEY, St. of Perak 7144 (K, Si).

SUMATRA: Benkoelen, Enggano, Boea-boea, c. 100 m alt., in the river, 30 V 1936, LÜTJEHARMS 3935 and 4343 (L).

JAVA: Malang, Roemah klampok, 300 m alt., 14 V 1936, J. H. ? 74 (Bz).

BORNEO: without exact locality, no date[1]), MOTLEY 728 (K).

Remarks. Variety *Glaziovii* is much more robust than var. *microglochin*, and is otherwise distinguished in having one or more elongate dactyls; it has larger oogonia than this var. and var. *papuana*.

Ecology. In a river; covered with clay and overgrown with

[1]) MOTLEY collected here between 1854 and 1859.

epiphytes. In one case together with *N. acuminata*. Malaysian plants with ripe oospores have been collected in March and May.

Distribution. Between 5° N. and 35° S.; ASIA, Malaysia: Malay Peninsula, Sumatra, Java, Borneo. Moreover in lit.: Bengal, AGHARKAR & KUNDU (1937, p. 8) — AMERICA, S. Am.: Brazil, ZELLER (1876, p. 428), NORDSTEDT (1889, p. 11), BRAUN & NORDSTEDT (1882, p. 73) — AFRICA, S. Afr.: Cape Colony, NORDSTEDT (1889, p. 27).

var. γ **papuana** ZANEV., nov. var.

Planta tenuis, elongata. *Caulis* 500—600 μ diam. *Dactyli* saepe inaequales, interdum omnes abbreviati vel unus duobus aliis multo longior, 2- (vel interdum 3-) cellulati; cellula inferior ad 1000 μ longa, 70—100 μ lata; cellula ultima conica, ad 90 μ longa, basi c. 45 μ lata. ♂ et ♀ *gametangia* ad nodos 3 primarios, verticilli basi nulla. *Oogonia* 480—570 μ longa (coronula inclusa), 340—370 μ lata; *oosporae* 300—350 μ longae, 260—320 μ latae.

NEW GUINEA: Papua, Rouna, in a pool on an enormous rock in Laloki river, c. 60 m alt., 29 V 1935, CARR 12425 (B and L, *type*).

Remarks. The plants of this new variety are extremely flexible, and fixed to the paper and to each other. This variety comes very near to var. *Glaziovii*, but differs in having larger oogonia.

Ecology. In a pool on a rock.

Distribution. 3° S.; ASIA, Malaysia: New Guinea.

3. Series PLURICELLULATAE J. GROVES in Journ. Bot. 73, 1935, p. 49; GROVES & ALLEN in Proc. Roy. Soc. Queensl. 46, 1925, p. 41; ZANEVELD in Blumea 3, 1939, p. 380 — *Nitellae flabellatae* A. BRAUN in HOOKER's Journ. Bot. 1, 1849, p. 198, *pro parte* — Subsect. *Polyarthrae* A. BRAUN ap. VON LEONHARDI in Lotos 13, 1863, repr. p. 11; id. in Verh. naturf. Ver. Brünn 2, 1864, repr. p. 39; BRAUN, Consp. syst. Charac. europ., 1867, p. 2 — Sect. *Polyarthrodactylae* A. BRAUN in Monatsber. Kön. Akad. Wiss. Berlin f. 1867, p. 797, 1868; BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 14; T. F. ALLEN, Charac. America 1, 1888, p. 48; MIGULA, Die Charac., 1897, p. 98; NORDSTEDT in Proc. Roy. Soc. Vict., N.S. 31, 1918, p. 3; KUNDU in Journ. Ind. Bot. Soc. 16, 1937, p. 266 — Subsect. *Arthrodactyles* HY in Bull. Soc. bot. France 60, 1913, Mém. 26, p. 16, *pro parte*.

Dactyls (ultimate rays of the branchlets) indifferently 2—6-celled.

29. Nitella Alleninda ZANEV., nov. spec.

Illustrations. The pres. paper, figs. 3*a—h*.

Planta monoica, minima, gracillima, ad 3—5 cm alta, pallide brunnea. *Caulis* tenuis, 250 μ diam. *Internodia* ramulis breviora vel aequalia. *Verticillorum ramuli steriles* normaliter 6, aequales, c. 1.5 cm longi, simplices bis furcati; radii primarii $^1/_2$—$^1/_3$ totius longitudinis ramulorum; radii secundarii 4—5, eorum 1—2 in radios 2—4 tertiarios furcati. *Verticillorum ramuli fertiles* 6—7, longitudine sterilium aequales, plerumque 3-plo interdum 4-plo furcati, radii primarii $^2/_3$ totius longitudinis ramulorum; radii secundarii 5—6; radii tertiarii 4—5 eorum 1—3 in radios quaternarios 2—4 furcati; omnes radii gradatim breviores, ultimis longissimis exceptis. *Dactyli* steriles 2—4, (2—)4(—5)-cellulati mucrone 65—130 μ longa, basi 25—45 μ lata; dactyli fertiles 2—4, 3(—5)-cellulati, mucrone 30—90 μ longa, basi 15—25 μ lata; omnes cellulae gradatim breviores; cellula superior conica, cellula penultima apice rotundata. ♂ et ♀ *gametangia* sessilia, conjuncta, in omnibus nodis liberis, nodo primo excepto. *Antheridia* solitaria, terminalia, c. 205 μ diam. *Oogonia* solitaria, lateralia, 361—395 μ longa (coronula incl.), 260—271 μ lata, striis 7—8; *coronula* 45—56 μ alta, basi 51—62 μ lata; *oosporae* 237—249 μ longae, 187—205 μ latae, striis 6; *membrana* oosporae tuberculata.

Plant monoecious, very small and graceful, only 3—5 cm high, pale-brown, not incrusted at all. *Stem* very slender, up to 250 μ in diam. *Internodes* as long as or somewhat shorter than the branchlets. *Sterile branchlets* 6—7 in a whorl, the longest 1.5 cm, frequently once, seldom twice furcate; primary rays $^1/_2$—$^1/_3$ as long as the entire branchlet; secondary rays 4—5, of which 1 or 2 are sometimes again furcate into 2—4 tertiary rays; only the lowest 1—2 whorls being sterile. *Fertile branchlets* 6—7 in a whorl, c. 1.5 cm long, forming loose heads, thrice furcate; primary rays $^2/_3$ the length of the entire branchlet; secondary rays 5—6, much shorter than the primary ones, all divided into 4—5 tertiary rays, of which 1—3 are again forked into 2—4 quaternary rays; the ultimate rays are always much longer than the penultimate ones. *Dactyls* 2—4, 2—5-celled, in the sterile whorls usually 4-celled, ultimate cell 65—130 μ long, 25—45 μ wide at base; in the fertile whorls usually 3-celled, ultimate cell 30—90 μ long, 15—25 μ wide at base; successive cells in both kinds of dactyls gradually shorter, penultimate cell rounded at the apex, ultimate cell $^1/_3$ as broad as the penultimate one; dactyls all different in length. ♂ and ♀ *gametangia* sessile, together at the same and all free branchlet-nodes, except the lowest one and the base of the whorls, not enveloped in mucus. *Antheridia* solitary, terminal, c. 205 μ in diam., earlier ripe

than the oogonia. *Oogonia* solitary, lateral, 361—395 μ long (incl. coronula), 260—271 μ wide; *spiral-cells* showing 7—8 convolutions; *coronula* 45—56 μ high, 51—62 μ wide at base, persistent; *oospores* dark-brown to almost black, 237—249 μ long, 187—205 μ wide, with 6 ridges; *outer membrane* tuberculate.

JAVA: P r i a n g a n, near Tjiparoegpoeg, in a little pool in a valley of the G. Papandajan, c. 2500 m alt., 14 V 1931, VAN STEENIS 4799 (Bz), *type*.

R e m a r k s. This graceful species is the only and first member of the *Polyarthrodactylae* collected in the Netherlands Indies. It has much resemblance with the only European species of this section, *N. ornithopoda*, also occurring in Africa, and with *N. havaiensis* from the Sandwich Islands. These are both robust plants, and have the oogonia and antheridia clustered, whereas they are solitary in the present species. For *N. ornithopoda* the aggregated oogonia are not mentioned, but I have studied the plants from the Gironde, collected by MOTELAY (cf. "Fragmente", 1882, p. 90), which show this feature. This species differs moreover in having less furcate fertile branchlets, a lower number of rays at the different nodes, smaller antheridia, and larger oogonia. Moreover, in *N. havaiensis* the first branchlet-node is fertile.

A third allied species is *N. bonaerensis* from S. America, which I have not seen. This is a more robust plant, with more furcate branchlets, whereas the penultimate cell is frequently as narrow as the ultimate one. ALLEN & HERTER write (1934, p. 90), that a plant collected in Uruguay differs from the type in being sterile at the first forking.

The specific name commemorates Mr G. O. ALLEN, the indefatigable collector of and publicist on Indian *Charophyta*.

E c o l o g y. "A very delicate species with orange organs" and "very frequent in a pool of 20 cm² with a depth of 3—4 cm", are annotations given on the herbarium-label.

D i s t r i b u t i o n. 7° S.; ASIA, M a l a y s i a: Java.

II. Sectio H E T E R O C L E M A E J. GROVES in Journ. Linn. Soc., Bot., 46, 1924, p. 360; G. O. ALLEN in Journ. Ind. Bot. Soc. 7, 1928, p. 51; PAL in Journ. Linn. Soc., Bot., 49, 1932, p. 64; J. GROVES in Journ. Bot. 73, 1935, p. 47; GROVES & ALLEN in Proc. Roy. Soc. Queensl. 46, 1935, p. 41; ZANEVELD in Blumea 3, 1939, p. 380 — Subsect. *Heterophyllae* A. BRAUN in Flora 22, 1839, p. 310; id. in HOOKER's Journ. Bot. 1, 1849, pp. 195, 197; VON LEONHARDI in Lotos 13, 1863, repr. p. 9; id.

in Verh. naturf. Ver. Brünn 2, 1864, repr. p. 39; A. BRAUN, Consp. syst. Charac. europ., 1867, p. 2; BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, pp. 10, 13; T. F. ALLEN, Charac. America 1, 1888, pp. 43, 48; MIGULA, Die Charac., 1897, p. 98; H. & J. GROVES in URBAN, Symb. Antill. 7, 1911, p. 31; PRINTZ in ENGLER & PRANTL, Nat. Pfl. fam. 3, ed. 2, 1927, p. 427; NORDSTEDT in Proc. Roy. Soc. Vict. 31, N.S., 1918, p. 3 — *Nitellae furcatae heterophyllae* A. BRAUN in N. Denkschr. Schweiz. Ges. Naturw. 10, 1849, p. 10 — Subsect. *Heteroclemae* GROVES & BULLOCK WEBSTER, Brit. Charoph. 1, 1920, p. 126.

Each whorl of branchlets consisting of two or more rows, viz. one primary row composed of elongate and compound branchlets, and one or more accessory rows above and below the primary one, formed by small and less furcate branchlets.

30. Nitella hyalina [1]) (DC.) AGARDH, Syst. Alg., 1824, p. 126, *pro parte*; BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, pp. 14, 79 (var. *indica*); J. GROVES in Journ. Linn. Soc., Bot., 46, 1924, pp. 362, 369; G. O. ALLEN in Journ. Bombay Nat. Hist. Soc. 30, 1925, p. 597; id. in Journ. Ind. Bot. Soc. 7, 1928, p. 59, pl. 5, f. 1; DIXIT in Journ. Ind. Bot. Soc. 10, 1931, p. 205; PAL in Journ. Linn. Soc., Bot., 49, 1932, pp. 64, 66; MUKERJI in Proc. 19th Ind. Sci. Congr., Bangalore, 1932, p. 328; G. O. ALLEN in Journ. Ind. Bot. Soc. 12, 1933, p. 17; MUKERJI in Proc. 21st Ind. Sci. Congr., Bombay, 1934, p. 295; AGHARKAR & KUNDU in Journ. Dep. Sci., N.S., 1, 1937, pp. 3, 9, pl. 5, figs. 1, 2; STEWART in Journ. Mitchell Soc. 53, 1937, p. 173, text-f. 1 and pl. 16 — *Chara hyalina* DE CANDOLLE, Fl. Franç. 5, 1815, p. 247, *pro parte*.

Plant monoecious, medium-sized, up to 30 cm high. *Internodes* 2—4 times the length of the branchlets. *Branchlets* in three rows of 8 each, two rows of short accessory branchlets, one above and one below the longer middle primary branchlets. Primary branchlets 2—3 times furcate; secondary rays 7—10. *Dactyls* 4—5, uniformly two-celled. *Accessory branchlets* of the upper row once furcate into 5 rays; those of the lower row once or twice furcate into 4—6 rays. ♂ and ♀ *gametangia* together at all nodes of the primary branchlets and occasionally at those of the accessory branchlets, solitary, enveloped in mucus. *Antheridia* 350—425 μ in diam. *Oospores* reddish brown, 250—335 μ long, with 6—7 ridges. *Membrane* granulate.

Remarks. It is somewhat surprising that this species is not yet collected in Malaysia as it is very common both in India and in Australia. Identified at once by the presence of the accessory branchlets. No Malaysian specimens examined.

[1]) The literature here mentioned concerns only the area under discussion; other articles, illustrations and synonyms (not seen by the author) are to be found in BRAUN & NORDSTEDT (1882, p. 7), MIGULA (1897, p. 190) and in GROVES & BULLOCK WEBSTER (1920, p. 127).

Ecology. In the shallower water of pools, etc. DIXIT (1931, p. 205) has found it in a saltwater mudflat near the sea shore.

Distribution. Between 70° N. and 40° S.; EUROPE — ASIA: Songaria; Persia; India; China; Japan — N. & S. AFRICA — N., C. & S. AMERICA — AUSTRALIA.

2. TOLYPELLA A. BR. emend. VON LEONH.

Genus TOLYPELLA VON LEONHARDI in Lotos 13, 1863, reprint p. 12; id. in Verh. naturf. Ver. Brünn, 2, 1864, repr. p. 39; A. BRAUN in COHN, Krypt. Fl. Schles. 1, 1876, pp. 368, 400; BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 93; T. F. ALLEN, Charac. America 1, 1888, p. 51; id. in Bull. Torrey Bot. Cl. 10, 1883, p. 109; MIGULA, Die Charac., 1897, p. 198; NORDSTEDT in Proc. Roy. Soc. Vict., N. S. 31, 1918, p. 4; GROVES & BULLOCK WEBSTER, Brit. Charoph. 1, 1920, p. 129; J. GROVES in Journ. Linn. Soc., Bot., 46, 1924, p. 360; G. O. ALLEN in Journ. Bombay Nat. Hist. Soc. 30, 1925, p. 592; PRINTZ in ENGLER & PRANTL, Nat. Pfl. fam. 3, ed. 2, 1927, p. 426 — Sect. *Caudatae* A. BRAUN in N. Denksehr. Schweiz. Ges. Naturw. 10, 1849, p. 11 — Subgen. *Tolypella* A. BRAUN in HOOKER's Journ. Bot. 1, 1849, p. 199, *pro parte*; id. in Monatsber. Kön. Akad. Wiss. Berlin f. 1867, p. 797, 1868; id., Consp. syst. Charac. Europ., 1867, p. 3 — Sect. *Pseudobracteatae* WALLMAN, Försök. syst. Charac., 1853, p. 39, *pro parte*; id. in Act. Soc. Linn. Bordeaux 21, 1856, p. 13.

Branches usually more than two at a stem-node. *Sterile branchlets* simple or furcate; *fertile branchlets* furcate with very unequal rays, normally forming dense heads. ♂ and ♀ *gametangia* frequently long-stalked. *Antheridia* solitary, lateral at the nodes of the branchlets and, at times, also at the base of the whorls, thus representing secondary rays. *Oogonia* always aggregated, originating from the basal node-cell of the antheridium, or from those of the primary rays, thus representing a branchlet of a higher order than the antheridium. *Oospores* subglobose, hence terete in transverse section.

Remarks. According to T. F. ALLEN (1882, p. 109) the genus is to be divided into two sections on account of the shape of the ultimate cell of the rays and the branchlets.

Distribution. About 14 species in fresh and brackish water in all parts of the world, especially in the northern hemisphere.

Key to the sections and species [1]).

1a. Ultimate cell of the branchlets and rays conical (Conoideae) . . . . . 1. *T. prolifera*

b. Ultimate cell of the branchlets and rays obtuse (Allantoideae) . 2

2a. Antheridia 700—750 μ in diam. . . . . 2. *T. hispanica*

b. Antheridia 325—375 μ in diam. . . . . 3. *T. glomerata*

I. Sectio CONOIDEAE GROVES & BULLOCK WEBSTER, Brit. Charoph. 1, 1920, p. 130; J. GROVES in Journ. Linn. Soc., Bot., 46, 1924, pp. 362, 370 — Sect. *Acutifolia* T. F. ALLEN in Bull. Torrey Bot. Cl. 10, 1883, p. 110; id., Charac. America 1, 1888, p. 51.

[1]) Cf. note [1]) on p. 51.

Ultimate cell of the branchlets and rays conical, acute and short. Spiral-cells of oogonium not swollen at the apex. Coronula persistent.

1. **Tolypella prolifera**[1]) (WALLR.) VON LEONHARDI in Lotos 13, 1883, repr. p. 57; J. GROVES in Journ. Linn. Soc., Bot., 46, 1924, pp. 362, 370; G. O. ALLEN in Journ. Bombay Nat. Hist. Soc. 30, 1925, p. 597; id in Journ. Ind. Bot. Soc. 7, 1928, p. 60, pl. 5, text-f. 8; id. in Journ. Ind. Bot. Soc. 15, 1936, p. 51 — *Chara translucens* AG. var. *prolifera* WALLROTH in Fl. Crypt. Germ., 1833, p. 106.

Plant monoecious, very stout, up to 35 cm high. *Branchlets* 6—20 in a whorl, very unequal; *sterile branchlets* simple, much elongate, 3—5 celled; *fertile branchlets* in dense heads, once or twice furcate. *Rays* 2—3 at each node, simple or furcate. Dactyls 3—5-celled; ultimate cell conical. ♂ and ♀ *gametangia* at the branchlet-nodes and at the base of the whorls. *Antheridia* c. 300 μ in diam. *Oospores* dull-brown, 330—400 μ long, with 9 ridges. *Membrane* flat.

Remarks. Different from the related *Tolypella intricata* by the stout non-furcating sterile branchlets. No Malaysian specimens examined.

Ecology. In shallow water of ditches and in rivers with a low velocity. According to ALLEN (1928, p. 60) the species is very constant in the time of appearance: it commences in December and ripe oospores are still found in February.

Distribution. Between 50° N. and 40° S.; EUROPE — ASIA, INDIA: Gangetic Plain; China: Yunnan — N. and S. AMERICA.

II. Sectio ALLANTOIDEAE GROVES & BULLOCK WEBSTER, Brit. Charoph. 1, 1920, p. 135; J. GROVES in Journ. Linn. Soc., Bot., 46, 1924, pp. 362, 370 — Sect. *Obtusifolia* T. F. ALLEN in Bull. Torrey Bot. Cl. 10, 1883, p. 110; id., Charac. America 1, 1888, p. 51.

Ultimate cell of the branchlets and rays allantoid, rounded at the apex and not abbreviated. Spiral-cells of the oogonium not swollen at the apex at maturity. Coronula deciduous.

2. **Tolypella hispanica**[1]) NORDSTEDT in Act. Univ. Lund. 25, 1889, pp. 18, 14, f. 44; T. F. ALLEN, Charac. America 1, 1888, p. 51 (*nom. tant.*); OFFNER in Bull. Soc. bot. France 70, 1922, p. 77; J. GROVES in Journ. Linn. Soc., Bot., 46, 1924, pp. 362, 370.

Plant dioecious, moderately stout. The description is similar to that of the following species, *T. glomerata*, the gametangia excepted. *Antheridia* stalked, 700—750 μ in diam. *Oospores* brown, 225—300 μ long, with 7—8 ridges. *Membrane* finely granulate.

Remarks. This species, which has never been adequately described, is closely allied to *T. glomerata*. No specimens examined.

Ecology. In rivers.

---

[1]) The literature here mentioned concerns only our area; further titles, synonyms (not checked by the author) and illustrations are to be found in BRAUN & NORDSTEDT (1882, p. 97), MIGULA (1897, p. 203), GROVES & BULLOCK WEBSTER (1920 p. 133).

Distribution. Between 45° N. and 25° N.; EUROPE — ASIA, Persia; India: India Deserta — N. AFRICA.

3. **Tolypella glomerata**[1]) (DESV.) VON LEONHARDI in Lotos 13, 1863, repr. p. 57; J. GROVES in Journ. Linn. Soc., Bot., 46, 1924, pp. 362, 370 — *Chara glomerata* DESVAUX ap. LOISELEUR-DESLONGCHAMPS, Not. Pl. aj. Fl. France, 1880, p. 135.

Plant monoecious, moderately stout. *Branches* usually 2—6 at a stem-node. *Branchlets* 6—12 in a whorl; *sterile branchlets* simple, elongate, 3—5-celled; *fertile branchlets* in dense heads, once furcate. *Rays* 4—5, the central ray 3—4-celled, the lateral 3-celled. *Ultimate* cell obtuse. ♂ and ♀ *gametangia* at the nodes of the branchlets, and oogonia frequently at the base of the whorls. *Antheridia* 325—375 μ in diam. *Oospores* brown, 300—375 μ long, with 7—9 ridges. *Membrane* linear-granulate.

Remarks. This species resembles very much *T. nidifica*, which differs in having much larger gametangia, claret oospores, and a smooth oospore-membrane.

Ecology. In brackish and fresh water of pools and ditches.

Distribution. Between 60° N. and 45° S.; EUROPE — ASIA, India: W. Himalaya, India Deserta; China? — N. AMERICA — AFRICA.

II. CHAREAE VON LEONH.

Tribus CHAREAE VON LEONHARDI in Lotos 13, 1863, repr. p. 12; id. in Verh. naturf. Ver. Brünn 2, 1864, repr. p. 40; H. & J. GROVES in URBAN, Symb. Antill. 7, 1911, p. 31; HY in Bull. Soc. bot. France 60, 1913, Mém. 26, p. 5; GROVES & BULLOCK WEBSTER, Brit. Charoph. 2, 1924, p. 1; J. GROVES in Journ. Linn. Soc., Bot., 46, 1924, p. 360; PRINTZ in ENGLER & PRANTL, Nat. Pfl. fam. 3, ed. 2, 1927, p. 428; PAL in Journ. Linn. Soc., Bot., 1932, p. 64; GROVES & ALLEN in Proc. Roy. Soc. Queensl. 46, 1935, p. 40; ZANEVELD in Blumea 3, 1939, p. 378 — Gen. *Chara* AGARDH, Syst. Alg., 1826, p. XXVII; BRAUN in N. Denkschr. Schweiz. Ges. Naturw. 10, 1849, p. 12; id. in HOOKER's Journ. Bot. 1, 1849, p. 200; id., p. 294; id., Consp. syst. Charac. europ., 1867, p. 3; id. in Monatsber. Kön. Akad. Wiss. Berlin f. 1867, p. 797, 1868 — *Charae pleurogynae* et *hypogynae* A. BRAUN in Ann. Sci. Nat. 1, sér. 2, 1834, p. 353; id. in Flora 18, 1835, pp. 12, 57, 58; id. in Linnaea 17, 1843, pp. 116, 117 — Fam. *Chareae* A. BRAUN in COHN, Krypt. Fl. Schles. 1, 1876, pp. 368, 402; BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 16; T. F. ALLEN, Charac. America 1, 1888, p. 52 (*Charae*); G. O. ALLEN in Journ. Bombay Nat. Hist. Soc. 30, 1925, p. 592 — Subfam. *Chareae* A. BRAUN ap. MIGULA, Die Charac., 1897, p. 252; ROBINSON in Bull. New York Bot. Gard. 4, 1906, p. 253.

Plants with (generally in corticated species) or without calcareous incrustation. Stem and branchlets with or without *cortical-cells*.

[1]) Cf. note on p. 110.

Branches, similar to the main stem, usually one at a stem-node in the axil of the oldest branchlet. *Branchlets* 6—12 in a whorl on each stem-node, not furcate, with one-celled bract-cells at the branchlet-nodes. *Stipulodes,* being one-celled organs, at the base of the branchlets, rudimentary or present in a single or double row. Cells of the *coronula* in a single row of five cells.

Key to the genera.

1a. Stipulodes rudimentary; bract-cells 1—3 at a node, very long; branchlets consisting of 2—5 very long articulations; ecorticate; dioecious, antheridia and oogonia lateral . . . . . **3. Nitellopsis**

b. Stipulodes present, sometimes rudimentary; bract-cells normally 4 or more, short; branchlets consisting of 4 or more articulations; corticate or ecorticate; dioecious or monoecious 2

2a. Antheridium situated above the oogonium (not yet collected in our area) . . . . . **4. Lamprothamnium**

b. Antheridium situated at either side of each oogonium . . **5. Lychnothamnus**

c. Antheridium situated below the oogonium . . . . . **6. Chara**

Note. As I already pointed out in Blumea 3, 1939, p. 378, FILARSZKY's genus *Charina* (1937, p. 490) from Western Australia is too badly defined to give it a place in the *Charophyta* system. The description is only based on vegetative parts of a plant mounted on a microscopical slide and nothing can be said about the situation of the gametangia which procure at present important features for the classification of the genera. It is much to be hoped that the plant may be collected again.

3. NITELLOPSIS Hy

Genus NITELLOPSIS Hy in Bull. Soc. bot. France 36, 1889, p. 397; GROVES & BULLOCK WEBSTER, Brit. Charoph. 2, 1924, p. 2; J. GROVES in Journ. Linn. Soc., Bot., 46, 1924, pp. 360, 370; G. O. ALLEN in Journ. Bombay Nat. Hist. Soc. 30, 1925, p. 592; PRINTZ in ENGLER & PRANTL, Nat. Pfl. fam. 3, ed. 2, 1927, p. 428; PAL in Journ. Linn. Soc., Bot., 49, 1932, p. 64 — *Nitella* sect. *Pseudobracteatae* WALLMAN in Act. Soc. Linn. Bordeaux 21, 1856, p. 33, *pro parte* — *Chara* subgen. *Tolypellopsis* VON LEONHARDI in Lotos 13, 1863, repr. p. 13 — *Chara* sect. *Tolypellopsis* VON LEONHARDI in Verh. naturf. Ver. Brünn. 2, 1864, repr. p. 41 — *Chara* sect. *Astephanae* A. BRAUN, Consp. syst. Charac. europ., 1867, p. 3; id. in Monatsber. Kön. Akad. Wiss. Berlin f. 1867, p. 798, 1868; id. in COHN, Krypt. Fl. Schles. 1, 1876, p. 402 — *Tolypellopsis* (VON LEONH.) MIGULA, Die Charac., 1890, p. 253.

Stem and branchlets entirely without *cortical-cells. Stipulodes* rudimentary. *Branchlets* with 2—5 articulations. *Bract-cells* 1—3 at

each branchlet-node, much elongated. *Bracteoles*, being one-celled organs originating from the node at the base of the oogonium, absent. ♂ and ♀ *gametangia* arising as direct outgrowths from the peripheral cells of the branchlet-nodes.

Remarks. The discovery of a plant in the island of Lombok by Dr HEBERER, described below as *Nitellopsis sarcularis*, leads to an emendation of the diagnosis of the genus. The emendation concerns the branchlets, which do not have 2—3 but 2—5 articulations, and the stipulodes being not absent, but rudimentary. For further particulars I refer to *N. sarcularis*.

Distribution. Three species in fresh water of Europe, India, Malaysia, and Australia.

Key to the species [1]).

1a. Fertile branchlets with 2—3 free nodes. . . . . 1. *N. obtusa*
b. Fertile branchlets with 3—4 free nodes. . . . . 2. **N. sarcularis**

1. Nitellopsis obtusa [2]) (DESVAUX) J. GROVES in Journ. Bot. 57, 1919, p. 127; id. in Journ. Bot. 60, 1922, p. 54; id. in Journ. Linn. Soc., Bot., 46, 1924, p. 370; PAL in Journ. Linn. Soc., Bot., 49, 1932, p. 79; MUKERJI in Proc. 19th Ind. Sci. Congr., Bangalore, 1932, p. 328; id. in Proc. 21st Ind. Sci. Congr., Bombay, 1934, p. 295 — *Chara obtusa* DESVAUX ap. LOISELEUR-DESLONGCHAMPS, Not. Pl. aj. Fl. France, 1810, p. 136 — *Chara stelligera* BAUER ap. REICHENBACH in MOESSLER, Gemeinn. Handb. Gewächsk. 3, ed. 2, 1829, p. 1595 — *Nitella stelligera* KUETZING, Sp. Alg., 1849, p. 518; id., Tab. Phyc. 7, 1857, pl. 27 — *Lychnothamnus stelliger* A. BRAUN in Abh. Kön. Akad. Wiss. Berlin, 1882, pp. 17, 102, pl. 6, f. 189 — *Nitellopsis stelliger* HY in Rev. Bot. 8, 1890, p. 46 — *Tolypellopsis stelligera* (BAUER) MIGULA, Die Charac., 1890, p. 255, figs. 70—73.

Plant dioecious, robust, c. 40 cm high. Lower stem-nodes white, star-shaped, with long rhizoid-like branches. *Internodes* as long as or somewhat longer than the branchlets. *Branchlets* 5—7 in a whorl, consisting of 2—3 articulations. *Bract-cells* 1—2, up to as long as the ultimate branchlet-articulation. ♂ and ♀ *gametangia* 1—2 together at the two lowest nodes. *Antheridia* 750—1000 μ in diam. *Oospores* golden-brown, c. 775 μ long, with 7 ridges terminating in short basal claws. *Membrane* minutely granulate.

Remarks. This species is at once distinguished by its habit and when lower stem-nodes are collected, by their star-shape. The distribution is remarkable for the disjunct area. Different from *N. sarcularis* by the lower number of fertile branchlet-articulations. No Malaysian specimens examined.

Ecology. MUKERJI (1932, p. 328) collected the species in Kashmir at

---

[1]) Cf. note on p. 51.

[2]) European literature, other synonyms and illustrations are to be found in BRAUN & NORDSTEDT (1882, p. 102), MIGULA (1897, p. 255) and GROVES & BULLOCK WEBSTER (1924, p. 3).

a depth of about 25 feet together with *Nitella acuminata, N. flagelliformis* and *N. hyalina*. All these plants are able to withstand low intensities of light.

Distribution. Between 65° N. and 23° N.; EUROPE — ASIA, India, W. Himalaya, Burma.

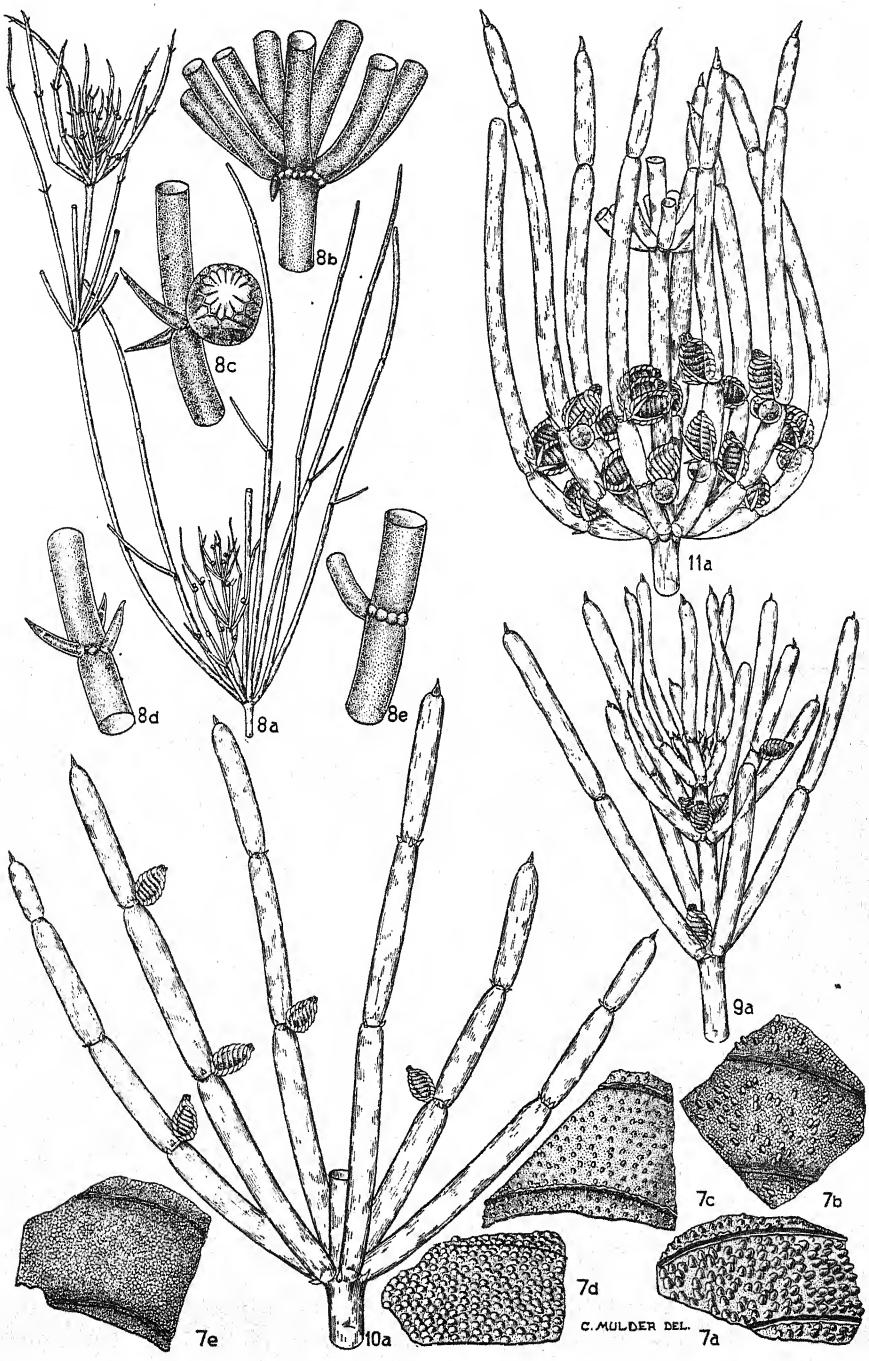
2. Nitellopsis sarcularis ZANEV., nov. spec.

Illustrations. The pres. paper, figs. 8*a*—*e*.

Planta dioica, gracilis, elongata. Planta feminea ignota. *Caulis* tenuis, 340—400 μ diam. *Internodia* quam ramuli 1—1½-plo longiora. *Stipulodia* uniseriata; plerumque non inchoata, apiculata. *Verticillorum ramuli steriles* 5—7, incurvati, ecorticati, 3—4 articulationibus, ad 4 cm longa. *Verticillorum ramuli fertiles* 6, in capitula congesti, incurvati, ecorticati, 4—5 articulationibus. *Bracteae* 2 laterales antheridiis aequales, 1 anteriore ramulis fertilibus orta parce evoluta, sterilibus autem elongata, ad 6 mm longa. *Antheridia* 1—2 aggregata, plerumque 2, in omnibus nodis primo sterili excepto, c. 450 μ diam.

Plant dioecious, slender, yellowish green, incrusted; most probably rather long (some small fragments of male plant only were collected). *Stem* slender, 340—400 μ in diam. *Internodes* as long as, or slightly longer than the sterile branchlets. *Stipulodes* rudimentary, only one found developed, small and apiculate, c. 133 μ long, 80 μ wide. *Sterile branchlets* 5—7 in a whorl, very long, up to 4 cm, slightly incurved, containing 2—3 free nodes, the articulations gradually tapering into the apex, though the second articulation is usually the longest, ultimate articulation long acuminate, or short conical, thus forming a mucro. *Fertile branchlets* 6 in a whorl, up to 1 cm long, forming loose heads, containing 3—4 free nodes, articulations as in the sterile branchlets. *Bract-cells* 1—3, up to 6 mm long (but then always only 1) at the lower nodes of the sterile branchlets, at the upper node frequently reduced to papillae; those of the fertile branchlets up to 450 μ long, but more

Fig. 7, *Nitella pseudoflabellata*, "NORDSTEDT-markings" of different oospore membranes; *a*. (var. *mucosa*) specimen collected by VAN STEENIS 4962b, × c. 275; *b*—*e*. var. *mutila*; *b*. and *c*. type specimen of Loemar, collected by E. VON MARTENS, × c. 275; *d*. specimen collected by ZIPPELIUS, × c. 275; *e*. specimen collected by JUNGHUHN (herb. VAN DEN BOSCH), × c. 275 — Fig. 8, *Nitellopsis sarcularis*, n. sp.; *a*. habit, × c. 2; *b*. stem-node with stipulodes, of which only one has developed, the others being rudimentary, × c. 12; *c*. branchlet-node with antheridium, × c. 22; *d*. branchlet-node with 2 two-celled bract-cells, × c. 23; *e*. branchlet-node, × c. 23 — Fig. 9, *Chara australis* var. *Vieillardii* f. *simplicissima*; *a*. part of female plant with whorls of fertile branchlets, × c. 5 — Fig. 10, *Chara fulgens*; *a*. stem-node with whorl of fertile branchlets, × c. 4 — Fig. 11, *Chara pashanii*; *a*. stem-node with whorl of fertile branchlet, × c. 4.


8b
8c
8d
8a
8e
11a
9a
7c
7b
7d
7e
10a
C. MULDER DEL.
7a

numerous, apiculate or acuminate, one-celled. *Antheridia* 1—2 together, frequently 2, at all free nodes, the ultimate one excepted and not at the base of the whorls, c. 450 μ in diam.

LOMBOK: Segara anak, alt. c. 2000 m, 1927, HEBEKER s.n. (Bz), *type*.

Remarks. It is a pity that only very few fragments of a male plant of this interesting genus were collected in Malaysia, as these fragments show important differences with the only species of this genus known at present and occurring in Europe and India. These particulars are: 1°. The fertile branchlets have rarely 3 articulations but usually 4, whereas the number of articulations of the sterile branchlets is usually 3 and seldom 2 (GROVES & BULLOCK WEBSTER remark for the genus [1928, p. 28]: "There is usually only one and never more than two nodes"); 2°. The ultimate cell of the sterile branchlets is elongated and frequently longer than the bract-cell on the same branchlet; those of the fertile branchlets are, however, usually short and conical (GROVES & BULLOCK WEBSTER, *l. c.*, write: "The apical cell, instead of being short and conical, is elongated and cylindrical"); 3°. The stipulodes are usually rudimentary though in one case a developed one was extant (f. 8*b*). As far as I know this has never been observed in the genus and it shows moreover, that the lower peripheral cells of the stem-nodes are indeed rudimentary stipulodes. This is in contradiction to MIGULA (1890, p. 266), who states: "dasz dieser Gattung ein Stipularkranz vollständig fehlt"; 4°. The number of bract-cells for *N. obtusa* is mentioned by GROVES & BULLOCK WEBSTER (*l. c.*, p. 4) as 1—2 and by MIGULA (1897, p. 258) as 1—3. In the present species the number is 1—3; 5°. Antheridia are normally geminate and rarely solitary at the inner side of the branchlets, thus quite the reverse of *N. obtusa*, and they are seldom surrounded by 1 or 2 bract-cells. The antheridia are smaller than in *N. obtusa*, viz. up to 500 μ in diam.

As the lower parts of the plant were not collected, unfortunately nothing can be said about eventual star-like nodes as are occurring in *N. obtusa*.

The above cited characters were hitherto not yet observed for *N. obtusa*, though it is obvious that the new species must be included in this genus. The diagnosis thereof is emended in this sense. The name was given to the species on account of the resemblance of the branchlets with a weed-hook.

In one case two bract-cells were two-celled (cf. f. 8*d*); the same was observed by NORDSTEDT (1866, p. 113) in *N. obtusa*.

Ecology. Unknown.
Distribution. On 8°30′ S.; ASIA, Malaysia: Lombok.

5. LYCHNOTHAMNUS (RUPR.) VON LEONH.

Genus LYCHNOTHAMNUS (RUPR.) VON LEONHARDI in Lotos 13, 1863, repr. p. 12; id. in Verh. naturf. Ver. Brünn 2, 1864, repr. p. 40; BRAUN & NORDSTEDT in Abh. Kön. Akad. Wish. Berlin, 1882, p. 102, *pro parte*; T. F. ALLEN, Charac. America 1, 1888, p. 52, *pro parte*; A. BRAUN in COHN, Krypt. Fl. Schles. 1, 1876, p. 401; MIGULA, Die Charac., 1897, p. 286; HY in Bull. Soc. bot. France 60, 1913, Mém. 26, p. 5; GROVES & BULLOCK WEBSTER, Brit. Charoph. 1, 1920, p. 91; J. GROVES in Journ. Linn. Soc., Bot., 46, 1924, p. 361; G. O. ALLEN in Journ. Bombay Nat. Hist. Soc. 30, 1925, p. 592; PRINTZ in ENGLER & PRANTL, Nat. Pfl. fam. 3, ed. 2, 1927, p. 428; AGHARKAR & KUNDU in Journ. Dep. Sci., N. S. 1, 1937, p. 3 — Sect. *Charae pleurogynae* A. BRAUN in Ann. Sci. Nat. 1, sér. 2, 1834, p. 353; id. in Flora 18, 1835, pp. 12, 57 — Gen. *Charopsis* KUETZING, Phyc. Gen., 1834, p. 319, *pro parte*; id., Phyc. germ., 1845, p. 256, *pro parte* — Sect. *Lychnothamnus* RUPRECHT in Beitr. Pfl. Russ. Reiches 3, 1845, p. 11, *pro parte* — Sect. *Charae barbatae* A. BRAUN in N. Denkschr. Schw. Ges. Naturw. 10, 1849, p. 12, *pro parte* — *Chara* subgen. *Lychnothamnus* A. BRAUN in HOOKER's Journ. Bot. 1, 1849, p. 200, *pro parte*; id., Consp. syst. Charac. europ., 1867, p. 3; id. in Monatsber. Kön. Akad. Wiss. Berlin f. 1867, p. 798, 1868.

Stem imperfectly corticate. *Stipulodes* in a single row, well developed. *Branchlets* ecorticate consisting of 3—5 articulations. *Bract-cells* 4—7 at each branchlet-node. *Bracteoles* 2. *Antheridia* at either side of each oogonium, proceeding from separate peripheral cells of the branchlet-node on either side of the cell which produces the oogonium; oogonium solitary.

Distribution. Only one species in fresh water of Europe and India.

1. Lychnothamnus barbatus[1]) (MEYEN) VON LEONHARDI in Verh. naturf. Ver. Brünn 2, 1864, pp. 40, 58; J. GROVES in Journ. Linn. Soc., Bot., 46, 1924, pp. 362, 371; G. O. ALLEN in Journ. Bombay Nat. Hist. Soc. 30, 1925, p. 597; AGHARKAR & KUNDU in Journ. Dep. Sci. 1, 1937, p. 10 — *Chara barbata* MEYEN in Linnaea 2, 1827, p. 75, pl. 3, figs. 7, 8; KUETZING, Tab. Phyc. 7, 1857, pl. 44, f. 1; WALLMAN in Act. Soc. Lin. Bordeaux 21, 1856, p. 45.

Plant monoecious, stout, c. 25 cm high. *Internodes* in the lower parts of the plant c. 10 cm long, in the upper parts as long as the branchlets. *Cortex* only present on the younger internodes of the stem. *Spine-cells* rudimentary. *Stipulodes* in a single whorl, twice as numerous as the branchlets, up to 1 cm long. *Branchlets* 7—10 in a whorl, consisting of 3—5 articulations; fertile branchlets more compact than the sterile ones. *Bract-cells* 4—7. *Bracteoles* 2. ♂ and ♀ *gametangia* at the three lowest nodes of the branchlets, not at the base of the whorls, at each

[1]) The literature here mentioned concerns only our area; for further titles, synonyms and illustrations I refer to BRAUN & NORDSTEDT (1882, p. 104) and MIGULA (1897, p. 287).

node one oogonium between two antheridia. *Antheridia* 200—250 μ in diam. *Oospores* dark reddish-brown, 660—720 μ long. *Membrane* tuberculate.

Remarks. The situation of the gametangia presents the most remarkable characteristic of this species. No Malaysian specimens examined.

Ecology. Very frequent in deep water of lakes and ponds. Ripe gametangia are found from December to April (ALLEN, 1925, pl. 5).

Distribution. Between 54° N. and 20° N.; EUROPE — ASIA, India.

6. **CHARA** VAILL. ex L., emend. AG., A. BR., VON LEONH.

Genus CHARA VAILLANT in Mém. Acad. Roy. Sci. Paris, 1719, p. 17; LINNAEUS, Gen. Plant. ed. 5, 1754, p. 491; PERSOON, Syn. Plant., 1807, p. 530, *pro parte*; AGARDH, Syst. Alg., 1824, p. XXVII; KUETZING, Phyc. Gen., 1843, p. 319; WALLMAN in Act. Soc. Linn. Bordeaux 21, 1856, p. 39; VON LEONHARDI in Lotos 13, 1863, repr. p. 12, *pro parte*; id. in Verh. naturf. Ver. Brünn 2, 1864, repr. p. 41, *pro parte*; A. BRAUN in HOOKER, Handb. New Zealand Fl., 1867, p. 550; id. in COHN, Krypt. Fl. Schles. 1, 1876, p. 402, *pro parte*; BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 105; T. F. ALLEN, Charac. America 1, 1888, p. 52; MIGULA, Die Charac., 1897, p. 299; DE WILDEMAN, Alg. Fl. Buitenz., 1900, p. 372; ROBINSON in Bull. New York Bot. Gard. 4, 1906, p. 254; RIDLEY in Journ. Straits Branch R. A. Soc. 80, 1919, p. 163; GROVES & BULLOCK WEBSTER, Brit. Charoph. 2, 1924, p. 10; J. GROVES in Journ. Linn. Soc., Bot., 46, 1924, p. 361; G. O. ALLEN in Journ. Bombay Nat. Hist. Soc. 30, 1935, p. 592; PRINTZ in ENGLER & PRANTL, Nat. Pfl. fam. 3, ed. 2, 1927, p. 428; PAL in Journ. Linn. Soc., Bot., 49, 1932, p. 79; GROVES & ALLEN in Proc. Roy. Soc. Queensl. 46, 1935, p. 40; AGHARKAR & KUNDU in Journ. Dep. Sci., N. S. 1, 1937, p. 3 — Gen. *Nitella* AGARDH, Syst. Alg., 1824, p. XXVII, *pro parte* — Sect. *Charae hypogynae* A. BRAUN in Ann. Sci. Nat. 1, sér. 2, 1834, p. 353; id. in Flora 18, 1835, pp. 12, 58; id. in Linnaea 17, 1843, p. 117 — Gen. *Charopsis* KUETZING, Phyc. Gen., 1843, p. 319, *pro parte* — *Chara* sect. *Charopsis* KUETZING ap. RUPRECHT in Beitr. Pfl. Russ. Reiches 3, 1845, p. 12 — *Chara* sect. *Chara* AGARDH ap. RUPRECHT in Beitr. Pfl. Russ. Reiches 3, 1845, p. 12 — *Chara* sect. *bracteatae* A. BRAUN in N. Denkschr. Schweiz. Ges. Naturw. 10, 1849, p. 13 — *Chara* subgen. *Chara* A. BRAUN in HOOKER's Journ. Bot. 1, 1849, pp. 200, 294.

Stem and *branchlets* corticate or ecorticate. *Stipulodes* always present, sometimes rudimentary. *Branchlets* consisting of 5—14 articulations. *Bract-cells* 5—7, the posterior ones frequently reduced. *Bracteoles*

usually 2. ♂ and ♀ *gametangia* in the monoecious species arising from the same peripheral cell of the branchlet-node, taking the place of a bract-cell. *Antheridium* produced below the oogonium.

Remarks. As a basis for the primary division of the genus before 1849, the number of cortical cell-rows with regard to the number of branchlets was used. From that year onwards the development of the stipulodes in a single or in a double whorl afford the ground for the main division. This classification, with the addition of the series *Gymnobasalia*, is followed here:

I. Sect. *Haplostephanae*
- I. Subsect. *Ecorticatae*
- II. „ *Corticatae*
  - 1. Series *Gymnoclemae*
  - 2. „ *Gymnopodes*

II. Sect. *Diplostephanae*
- I. Subsect. *Haplostichae*
- II. „ *Diplostichae*
  - 1. Series *Tylacanthae*
  - 2. „ *Aulacanthae*
- III. Subsect. *Triplostichae*
  - 1. Series *Gymnocladia*
  - 2. „ *Phloeobasalia*
  - 3. „ *Gymnobasalia*

Distribution. About 90 species in fresh and brackish water, in all parts of the whorld.

Key to the sections.

1a.	Stipulodes in a single whorl	I. HAPLOSTEPHANAE
b.	Stipulodes in a double whorl	II. DIPLOSTEPHANAE

Key to the species and subspecies [1]).

1a.	Stipulodes in a single whorl (Haplostephanae)	2
b.	Stipulodes in a double whorl (Diplostephanae)	15
2a.	Cortex on stem and branchlets absent	3
b.	Cortex on stem present, on branchlets absent or present	10
3a.	Stipulodes opposite the branchlets	4
b.	Stipulodes alternating with the branchlets	5
4a.	Oogonia, but not antheridia at base of branchlet-whorls; bract-cells at ultimate node of branchlets well developed	6. *C. succincta*
b.	Neither oogonia nor antheridia at base of branchlet-whorls; bract-cells lacking at ultimate node of branchlets	7. *C. pashanii*

[1]) Cf. footnote on p. 51.

5a. Plant dioecious 6
b. Plant monoecious 8
6a. Base of branchlet-whorls sterile; gametangia solitary . . . 4. **C. fulgens**
b. Base of branchlet-whorls fertile; gametangia aggregated 7
7a. Bract-cells reduced or wanting, only microscopically visible . **1. C. australis**
b. Bract-cells well developed, macroscopically visible . . . . **2.** *C. Wallichii*
8a. Gametangia not produced at base of branchlet-whorls 9
b. Gametangia produced at base of branchlet-whorls . . . . **3. C. corallina**
9a. Gametangia aggregated; branchlets with a corona-like termination . . . . . **5. C. Braunii**
b. Gametangia solitary; branchlets without a corona-like termination . . . . . **8.** *C. nuda*
10a. Cortex on branchlets imperfect (Gymnopodes) . . **12. C. hydropitys**
b. Cortex on branchlets absent (Gymnoclemae) 11
11a. ♂ and ♀ gametangia produced at different branchlet-nodes . . . . . **10. C. erythrogyna**
b. ♂ and ♀ gametangia produced at the same branchlet-nodes 12
12a. Bract-cells and spine-cells absent . . . . . **11.** *C. burmanica*
b. Bract-cells and spine-cells present 13
13a. Ripe oospores golden-brown . . . . . 9C. **C. fibrosa** ssp. **flaccida**
b. Ripe oospores black 14
14a. Stipulodes as numerous as the branchlets . . 9A. **C. fibrosa** ssp. **Benthamii**
b. Stipulodes twice as numerous as the branchlets . . . . . 9B. **C. fibrosa** ssp. **gymnopitys**
15a. Cortical cell-series of stem as numerous as the branchlets (Haplostichae). Plant dioecious . . . . . **13.** *C. canescens*
b. Cortical cell-series of stem more numerous than the branchlets. Plant monoecious or dioecious 16
16a. Cortical cell-series of stem twice as numerous as the branchlets (Diplostichae). Plant monoecious 17
b. Cortical cell-series of stem thrice as numerous as the branchlets (Triplostichae). Plant monoecious or dioecious 20
17a. Cortical-cells of primary series prominent; spine-cells on ridges (Tylacanthae) 18
b. Cortical-cells of secondary series more prominent; spine-cells in furrows (Aulacanthae) 19
18a. Cortex on branchlets absent . . . . . **14.** *C. Grovesii*
b. Cortex on branchlets imperfect . . . . . **15.** *C. contraria*
19a. Branchlets with two or more corticated articulations. Gametangia produced at branchlet-nodes giving rise to a cortex. Stipulodes ± developed . . . . . 16A. *C. vulgaris* ssp. *eu-vulgaris*
b. Branchlets entirely ecorticate. Gametangia produced at branchlet-nodes not giving rise to a cortex. Spine-cells rudimentary . . . . . 16B. *C. vulgaris* ssp. *squamosa*
20a. Cortex on branchlets absent (Gymnocladia) . . . **17.** *C. Handae*
b. Cortex on branchlets imperfect 21

21a. Basal branchlet-articulation ecorticated (Gymnobasalia) . . . . . 25. **C. zeylanica**
b. Basal branchlet-articulation corticated (Phloeobasalia) 22
22a. Plant dioecious 23
b. Plant monoecious 25
23a. Whitish bulbils present at the lower nodes of the stem . . 18. *C. aspera*
b. Whitish bulbils absent 24
24a. Stipulodes much longer than the spine-cells, which are rudimentary . . . . . 19. *C. infirma*
b. Stipulodes and spine-cells of equal length; both rudimentary . . . . . 20. *C. connivens*
25a. Basal branchlet-articulation not diaphanous, long. Cortical cell-series of branchlets twice the number of bract-cells 26
b. Basal branchlet-articulation subdiaphanous, short. Cortical cell-series of branchlets thrice the number of bract-cells 27
26a. Primary cortical-cells of stem more prominent than secondary ones. Stipulodes elongated . . . . . 22. *C. delicatula*
b. Primary cortical-cells of stem equally well developed as secondary ones. Stipulodes rudimentary . . . . . 21. **C. globularis**
27a. Spine-cells absent . . . . . 23. **C. inermis**
b. Spine-cells present . . . . . 24. **C. brachypus**

I. Sectio HAPLOSTEPHANAE A. BRAUN in N. Denkschr. Schweiz. Ges. Naturw. 10, 1849, p. 13; id. in HOOKER's Journ. Bot. 1, 1849, p. 200; id., id., p. 294; VON LEONHARDI in Lotos 13, 1863, repr. p. 13; id. in Verh. naturf. Ver. Brünn, 2, 1864, repr. p. 41; A. BRAUN, Consp. syst. Charac. europ., 1867, p. 3; id. in Monatsb. Kön. Akad. Wiss. Berlin f. 1867, p. 798, 1868; id. in COHN, Krypt. Fl. Schles. 1, 1876, p. 403; BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 17; T. F. ALLEN, Charac. America 1, 1888, p. 53; H. & J. GROVES in URBAN, Symb. Antill. 7, 1911, p. 31; NORDSTEDT in Proc. Roy. Soc. Vict. 31, N. S., 1918, p. 4; GROVES & BULLOCK WEBSTER, Brit. Charoph. 2, 1924, p. 11; J. GROVES in Journ. Linn. Soc., Bot., 46, 1924, p. 363; PRINTZ in ENGLER & PRANTL, Nat. Pfl. fam. 3, ed. 2, 1927, p. 429; G. O. ALLEN in Journ. Ind. Bot. Soc. 7, 1928, p. 60; PAL in Journ. Linn. Soc., Bot., 49, 1932, p. 65; GROVES & ALLEN in Proc. Roy. Soc. Queensl. 46, 1935, p. 53; ZANEVELD in Blumea 3, 1939, p. 381 — *Stenartreae* GANTERER, Oesterr. Charen, 1847, p. 12 — *Chara* subgen. *Charopsis* VON LEONHARDI in Lotos 13, 1863, repr. p. 13 — *Chara* sect. *Charopsis* VON LEONHARDI in Verh. naturf. Ver. Brünn 2, 1864, repr. p. 41.

Stipulodes in a single row, frequently well developed, sometimes rudimentary.

Key to the subsections.

1a. Stem and branchlets without cortical-cells . . . . . I. ECORTICATAE
b. Stem corticate, branchlets ecorticate or imperfectly corticate . II. CORTICATAE

I. Subsectio ECORTICATAE A. BRAUN in HOOKER's Journ. Bot. 1, 1849, pp. 200, 203; id., id., p. 294; id. in Monatsber. Kön. Akad. Wiss. Berlin f. 1867, p. 799, 1868; id. in COHN, Krypt. Fl. Schles. 1, 1876, p. 403; BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 17; T. F. ALLEN, Charac. America 1, 1888, p. 53; NORDSTEDT in Proc. Roy. Soc. Vict. 31, N. S., 1918, p. 4; GROVES & ALLEN in Proc. Roy. Soc. Queensl. 46, 1935, p. 53; ZANEVELD in Blumea 3, 1939, p. 380 — *Chara* sect. *Heterosiphoniae* WALLROTH, Fl. Crypt. Germ., 1833, p. 107 — *Chara hypogynae* sect. *Monosiphoniae* A. BRAUN (non WALLROTH) in Ann. Sci. Nat. 1, sér. 2, 1834, p. 353 — *Charopsis* subsect. *Ecorticatae* VON LEONHARDI in Lotos 13, 1863, repr. p. 13 — *Euchara* subsect. *Ecorticatae* VON LEONHARDI in Verh. naturf. Ver. Brünn 2, 1864, p. 42.

Cortical-cells on stem and branchlets lacking.

1. Chara australis R. BROWN, Prodr. Fl. Nov. Holl. 1, 1810, p. 346; A. BRAUN in Linnaea 17, 1843, p. 117; id. in LEHMANN's Plant. Preiss. 2, 1847, p. 284; id. in HOOKER's Journ. Bot. 1, 1849, p. 200; KUETZING, Spec. Alg. 1849, p. 519; WALLMAN in Vet. Akad. Handl. 1852, p. 284; id. in Act. Soc. Linn. Bordeaux 21, 1856, p. 47; A. BRAUN in HOOKER's Flora Tasman. 2, 1860, p. 159; id. in Monatsber. Kön. Akad. Wiss. Berlin f. 1867, 1868, p. 799 (*nom. tant.*); BRAUN & NORDSTEDT in Kön. Akad. Wiss. Berlin, 1882, p. 105; T. F. ALLEN, Charac. of Amer. 1, 1888, p. 53 (*nom. tant.*); HOLTZ in Mitt. Naturw. Ver. Neuvorpommern u. Rügen 36, 1905, p. 38; BAILEY, Compreh. Catal. Queensl. Pl., 1909, p. 678 (*nom. tant.*); NORDSTEDT in Proc. Roy. Soc. Vict. 31, 1918, p. 4 (*nom. tant.*); J. GROVES in Philipp. Journ. Sci. 19, 1921, p. 664; in Journ. Linn. Soc., Bot., 46, 1922, p. 70; GROVES & ALLEN in Proc. Roy. Soc. Queensl. 46, 1937, pp. 53, 54; HASSLOW, in Bot. Not., 1939, p. 301 — *Nitella pachyarthra*; *Nitella Stuartiana*; *Tolypellopsis simplicissima*; *Chara Stuartiana*; *Chara plebeja*; cf. varieties.

Plant dioecious, bright-green or brownish-green to almost white in the hyaline variety *lucida*, up to 35 cm high, not at all incrusted, therefore in a dried state very much flattened. *Stem* very stout (3.5 mm in diam. in f. *Stuartiana*) to slender (viz. 250—750 μ in var. *lucida*). *Internodes* ½—2 times as long as the branchlets. *Cortex* and *spine-cells* absent. *Stipulodes* very small and conical acute, up to c. 180 μ long

and c. 80 μ wide at base, single or in pairs, but always alternating with the branchlets. *Branchlets* 3—8 in a whorl, 0.5—4.5 cm long, consisting of 3—5, sometimes very swollen articulations, ultimate articulation very short, frequently conical, acute, somewhat curved, rarely obtuse (var. *plebeja*). *Bract-cells* not always developed, sometimes 3 present (130—300 μ long, 20—50 μ wide at base), at the ultimate node, however, frequently lacking. *Bracteoles,* if any, usually 1—2, similar to the bract-cells. ♂ and ♀ *gametangia* produced in great clusters at the base of the whorls, and 1—3 at the nodes of the branchlets, except the ultimate one. *Antheridia* when fresh red, 660—1250 μ in diam. *Oogonia* 800—1000 μ long (inclus. coronula), 530—740 μ wide; *spiral-cells* showing 7—9 broad convolutions; *coronula* 70—90 μ high, 140—250 μ wide at base, individual cells blunt at their apices, straight or spreading; *oospores* black, 550—800 μ long, 330—510 μ wide, with 7—8 ridges. *Bulbils* found in one specimen of the var. *nobilis* only.

Remarks. *Chara australis* is much variable in habit; the diam. of the stem of f. *tenerior* is only c. 325 μ, whereas that of f. *Stuartiana,* to which the most gigantic *Chara* specimens belong now known to exist, reaches a diam. of 3.5 mm. In table XII a review is given of the characters of the different varieties in my opinion worth while to

TABLE XII.

Characters \ Varieties	α *nobilis*	β *lucida*	γ *Vieillardii*
Habit	stout to robust	rather stout	fairly robust
Appearance	not glossy	extremely glossy	not glossy
Stem-diam. in mm	1—3.5	0.25—0.75	0.45—1.5
Internodes (w. r. t. length of branchlets)	½—2 × as long	½ × as long	1 × as long
Number of branchlets	3—6	6	6—8
Length of branchlets in cm	2—3	0.6—1.5	1.5—4.5
Number of articulations	3—5	5	4—5
Antheridia (diam. in μ)	800—1250	550—960	750—1250
Oospores (length in μ)	660—730	550—660	712—756

distinguish, though there is no sharp break, especially between the varieties *lucida* and *Vieillardii*.

BRAUN first distinguished *C. plebeja* as a separate species (1843, p. 118) but afterwards it was cited by this author as a subspecies (1882, p. 107). The characteristic feature by which it is distinguished from the other varieties of *C. australis* is the small and obtuse ultimate branchlet-articulation, though for the rest it is hardly different from var. *Vieillardii*. In my opinion it is best considered a variety, but as I did not see a specimen I should reserve decision.

C. australis is most nearly allied to *C. Wallichii* from which it may be distinguished by the bract-cells being visible with the naked eye. Another nearly related species, which it resembles much, moreover, in appearance is *C. corallina*, but this is monoecious.

During a long lapse of time *C. australis* was considered endemic in Australia and in some of the adjacent Eastern islands. However, in 1921 it was recorded by GROVES from Annam (Indo-China), and the present paper shows that it occurs in Sumatra and New Guinea.

Ecology. In bays, tributaries, waterholes in rivers, at the base of a cataract, the last two being habitats with more or less rapidly flowing water. In one case *Brasenia peltata*, a *Nymphaeacea*, is quoted as an inhabitant of the same locality, whereas *Chara fibrosa* ssp. *flaccida* and *C. zeylanica* are also found growing together. Plants with ripe gametangia are collected from November to July.

Distribution. Between 13° N. and 50° S.; circumtropic and Southern Temperate extending from Asia, Indo-China (GROVES, 1921, p. 664) southeastwards to Australia and New Zealand (cf. varieties).

var. *α* **nobilis** A. BRAUN in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 105.

Plants very stout to robust, greyish green. *Stem* 1—3.5 mm in diam. *Internodes* ½—2 times the length of the branchlets, heavily swollen and contracted in the nodes. *Branchlets* 3—6 in a whorl, 2—3 cm long, 1—3 mm in diam., consisting of 3—5 articulations. *Bract-cells* and *bracteoles* 180—300 μ long. *Antheridia* 800—1250 μ in diam. *Oogonia* 880—1000 μ long (incl. coronula), 670—740 μ wide; *coronula* 70—80 μ high, 140—200 μ wide at base; *oospores* 660—740 μ long, 480—510 μ wide. *Root-bulbils*, occurring in but one specimen, spherical, and present in clusters of 4—10 proceeding from the root-nodes.

Remarks. BRAUN has not cited BROWN's original specimen from "New Holland" under one of his varieties in the "Fragmente". However, as the specimens signed by BRAUN: "*nobilis*", are quite identic

with the type specimen of BROWN, the var. *nobilis* must be considered the typical one of the species.

Distribution. Between 20° S. and 45° S.; AUSTRALIA, Tasmania. Moreover in lit.: New Zealand, BRAUN & NORDSTEDT (1882, p. 105), NORDSTEDT (1889, p. 31).

f. 1. **typica** ZANEV., nov. form. — *Chara australis* R. BR. var. *nobilis* A. BRAUN in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 105; KUETZING, Tab. Phyc. 7, 1857, p. 11; NORDSTEDT in Hedwigia 70, 1888, p. 187; id. in Acta Univ. Lund. 25, 1889, p. 31; BAILEY, Compreh. Catal. Queensl. Pl., 1909, p. 678 — *Nitella pachyarthra* F. VON MUELLER in herb. Berolin.

Illustration. KUETZING, Tab. Phyc. 7, 1857, pl. 27, f. 2.

Planta robusta. *Caulis* 1—1.5 mm diam. *Internodia* quam ramuli ½—1-plo longiora, valde tumida. *Verticillorum ramuli* 5—6, ad 2 cm longa, c. 1 mm diam., 4—5 articulationibus. *Bracteae* et *bracteoli* c. 180 μ longi. *Antheridia* 180 μ diam.

Plants very stout. *Stem* 1—1.5 mm diam. *Internodes* ½—1 times as long as the branchlets, heavily swollen. *Branchlets* 5—6 in a whorl, up to 2 cm long, c. 1 mm in diam., showing 4—5 articulations. *Bractcells* and *bracteoles* c. 180 μ long. *Antheridia* 800—1000 μ in diam.

WEST AUSTRALIA: S. W. Division, Swan River, 1845, DRUMMOND s.n., herb. HOOKER in (B), ♂ and ♀; ibid., without date, DRUMMOND 228 (B), ♀; Queensland: Upper Brisbane River, no date, HARTMAN 305 (B), ♂; Australia felix, no date, F. VON MUELLER s.n., herb. SONDER in (B), ♂ and ♀; ibid., 1854, F. VON MUELLER s.n. (B), ♂; ibid., no date, F. VON MUELLER s.n. (B), ♂. with a remark by NORDSTEDT: "stipula bina alternantes"; ibid., no date, LEICHH. (= LEICHHARDT?) coll. s.n. (B), ♀ juv.[1]); E. coast of New Holland, 1802—'03, R. BROWN s.n. (B), ♂, fragments of the *type*[2]); New South Wales: Paramatta, c. 1867, W. WOOLS s.n. (B), ♂; ibid., without exact locality, MT BALFOUR's waterholes in the river, 17 XI 1843, no collector's name (B), ♀; Victoria: Honeysuckle Creek, in deep places of the river, 4 II 1853, F. VON MUELLER s.n. (B), ♂ and ♀[3]); ibid., without exact locality, 1858, F. VON MUELLER s.n. (B), ♂.

TASMANIA: without exact locality, 1858, GUNN 1000, herb. HOOKER in (B), ♂, 4 specimens one with bulbils; ibid., Launceston, bason of the cataract, no date and collector's name (B), ♂.

---

[1]) On the same sheet is a fragment belonging to this variety without mentioning the locality, enclosed in a cover on which is written: "*Nitella translucens* ? growing under *Brasenia peltata*".

[2]) ROBERT BROWN collected in tropical North Australia near Endeavour River, and in New South Wales near Port Jackson.

[3]) On the same sheet is another label on which Baron VON MUELLER himself wrote: "*Nitella pachyarthra*. In lacunis fluvii Broken River 4, Dr M.".

Remarks. The name suggests the most striking feature of this form for which ROBERT BROWN's plant is the type. KUETZING remarks to plate 27, f. 2 (1857, p. 11): "Bracteen fehlen gänzlich", however, this is not correct, as I have observed them.

Distribution. Between 20° S. and 45° S.; AUSTRALIA, S.W. Division, Queensland, New South Wales, Victoria; Tasmania. Moreover in lit.: New Zealand, BRAUN & NORDSTEDT (1882, p. 105); NORDSTEDT (1889, p. 31).

f. 2. **Stuartiana** (KUEZTING) ZANEV., nov. comb. — *Nitella Stuartiana* KUEZTING, Tab. Phyc. 7, 1857, p. 11 (non est *N. Stuartii* A. BR. = *N. congesta* A. BR.); BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 105 — *Chara Stuartiana* KUETZING in herb. SONDER in (B); BRAUN in Linnaea 25, 1852, p. 707.

Illustration. KUETZING, Tab. Phyc. 7, 1857, pl. 28, f. 1[1]).

Plant extremely robust. *Stem* 1.5—3.5 mm in diam. *Internodes* up to twice as long as the branchlets, very much swollen. *Branchlets* 3—5 in a whorl, 2—3 cm long, 1.5—3 mm wide, consisting of 3—4 heavily swollen articulations. *Bract-cells* and *bracteoles* c. 300 μ long. *Antheridia* c. 1250 μ in diam. *Oogonia* absent.

TASMANIA: South Esk River, "in flumine", no date, STUART s.n., herb. SONDER in (B, L), ♂, fragments of the *type* (probably STUART 1565, cf. BRAUN, 1852, p. 707); ibid., STUART s.n., without the remark: "herb. SONDER", (B), ♂.

Remarks. This form represents the largest *Chara,* and is at once recognized by its extremely robust habit, the extraordinarily swollen articulations and stem-internodes contracted into the nodes, and the 3—5 branchlets.

Distribution. Between 40° S. and 42° S.; AUSTRALIA, Tasmania.

var. β **lucida** A. BRAUN in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 106; BAILEY, Compreh. Catal. Queensl. Pl., 1909, p. 678.

Plants very glossy, transparent and flexible, if a number of plants are taken together the colour is brownish green. *Stem* slender to moderately stout, 250—750 μ in diam. *Internodes* half as long as the branchlets, cylindrical and hardly contracted into the nodes. *Branchlets* 6 in a whorl, 0.6—1.5 cm long, up to 0.5 mm in diam., composed of 5 articulations. *Bract-cells* and *bracteoles* c. 180 μ long. *Antheridia* 550—960 μ in diam. *Oogonia* 800—900 μ long (incl. coronula), 530—

[1]) In contradistinction to KUETZING's statement to this plate again that no bract-cells are extant, I must remark that I have seen them.

580 μ wide; *coronula* c. 90 μ high and c. 160 μ wide at base; *oospores* 550—660 μ long, 370—490 μ wide.

Remarks. The variety *lucida* is especially characterized by its glossy appearance. The New Guinea find is an interesting one for the extension of the area known for the collective species.

Distribution. Between 0° and 40° S.; ASIA, New Guinea — AUSTRALIA.

f. 1. **typica** ZANEV., nov. form.

Planta mediocriter robusta. *Caulis* ad 750 μ diam. *Verticillorum ramuli* ad 1.5 cm longa, 0.5 mm diam. *Antheridia* 660—960 μ diam.

Plant rather stout. *Stem* up to 750 μ in diam. *Branchlets* up to 1.5 cm long, 0.5 mm in diam. *Antheridia* 660—960 μ in diam.

N. E. NEW GUINEA: Morobe District, Wareo, 2000 m alt., 2 I 1936, CLEMENS 1459 (B), ♂ and ♀.

SOUTH AUSTRALIA: Northern Territory, Baines Creek, V 1856, F. VON MUELLER 5 (B), ♂ and ♀; ibid., Victoria River, no date, F. VON MUELLER 5 (B), ♂ and ♀, *type*.

Remarks. Distinguished from f. *tenerior* in being much more robust.

Distribution. Between 0° and 40° S.; ASIA, New Guinea — AUSTRALIA.

f. 2. **tenerior** A. BRAUN (in herb.), nov. form.

Habitus varietatis *lucidae*, sed in omnibus partibus minor. *Caulis* ad 350 μ diam. *Verticillorum ramuli* 6 mm longi. *Antheridia* 600 μ diam.

Habit as var. *lucida*, but much more slender. *Stem* up to 350 μ in diam. *Branchlets* not longer than 6 mm. *Antheridia* 600 μ in diam.

N. AUSTRALIA: Gulf of Carpentaria, without exact locality, 1856, F. VON MUELLER s.n. (B), ♂, *type*.

Remarks. As the specimens are distinctly recognizable by their small appearance, it seems worth while to distinguish this form. Only male plants collected.

Distribution. Between 10° S. and 20° S.; AUSTRALIA, Gulf of Carpentaria.

var. γ **Vieillardii** [1]) A. BRAUN in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 106.

Plants brownish green, transparent, not distinctly glossy. *Stem*

---

[1]) BRAUN writes in the "Fragmente" (1882, p. 106): *"Viellardi"*, however the spelling of this name must be an orthographic error, as the plant was named after its collector E. VIEILLARD. In accordance with the International Rules (1935, art. 70) I write *"Vieillardii"*.

slender to stout, 450—1500 μ in diam. *Internodes* as long as the branchlets, not swollen, not contracted into the nodes. *Branchlets* 6—8 in a whorl, 1.5—4.5 cm long, 0.5—1.25 mm in diam., showing 4—5 articulations, the ultimate one sometimes conical. *Bract-cells* and *bracteoles* more or less rudimentary and even up to 250 μ long. *Antheridia* 750—1250 μ in diam. *Oogonia* 1025 μ long (incl. coronula); 620—670 μ wide; *coronula* c. 130 μ high, c. 140 μ wide at base; *oospores* 712—756 μ long, 490—534 μ wide.

Remarks. This variety can be distinguished from var. *lucida*, which has nearly the same habit, by its not being distinctly glossy.

Distribution. Between 3° N. and 40° S.; Asia, Sumatra — Australia, New Caledonia, Fiji Islands. Moreover in lit.: New Zealand, cf. f. *typica*.

f. 1. **typica** Zanev., nov. form. — *Chara australis* R. Brown var. *Vieillardii* A. Braun in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 106; Nordstedt in Hedwigia 70, 1888, p. 188; id. in Acta Univ. Lund. 25, 1889, p. 32.

Illustration. Braun & Nordstedt in Abh. Kön. Akad. Wiss. Berlin, 1882, pl. 7, f. 195.

Planta mediocriter robusta, translucens, flexilis. *Verticillorum ramuli* 6, 2.5—3 cm longi, 1.25 mm diam., 5-articulati. *Bracteae* et *bracteoli* c. 250 μ longi. *Antheridia* 750—1250 μ diam.

Plants fairly stout and flexible, transparent. *Stem* 1—1.5 mm in diam. *Branchlets* 6 in a whorl, 2.5—3 cm long, 1.25 mm in diam., showing 5 articulations. *Bract-cells* and *bracteoles* c. 250 μ long. *Antheridia* 750—1250 μ in diam.

New Caledonia: Pancher, 1869, F. von Mueller s.n. (B), ♂ and ♀, juv.

Remarks. The typical form and f. *simplicissima* are distinguished from f. *vitiensis* by having only one stipulode to each branchlet. Forma *typica* has the most robust habit of the three.

Distribution. Between 20° S. and 40° S.; New Caledonia. Moreover in lit.: New Zealand, Nordstedt (1889, p. 32).

f. 2. **vitiensis** Nordstedt in Hedwigia 70, 1888, p. 188; id. in Forschungsreise S. M. S. "Gazelle" 4, 1889, p. 8.

Illustrations. Nordstedt in Hedwigia, 70, 1888, pl. 6, figs. 3—6.

Stem up to 760 μ in diam. *Internodes* as long as the branchlets. *Branchlets* 6—8 in a whorl, c. 4.5 cm long, 800 μ in diam. consisting of 5 articulations. *Bract-cells* 2 and *bracteoles* 1, c. 130 μ long. *Antheridia* 750 μ in diam.

FIJI ISLANDS: O r a l a u, in the marshes near Bureta, VI 1882, WEBER s.n. (B), ♂ and ♀, *type*; ibid., Leruka, XI 1875, NAUMANN s.n.[1]) (B), ♂.

R e m a r k s. This form was separated by NORDSTEDT on account of the presence of two stipulodes at the base of each branchlet. It is an extremely slender form with proportionally long branchlets and internodes. The type possesses only very young oogonia, and the other plant is a male plant, therefore no dimensions of the oogonia can be given.

D i s t r i b u t i o n. Between 16° S. and 20° S.; Fiji Islands.

f. 3. **simplicissima** (FILARSZKY) ZANEV., nov. comb. — *Tolypellopsis* (*Nitellopsis*) *simplicissima* FILARSZKY in Arch. f. Hydrobiol. 1934, Suppl. Bd. 12, Trop. Binnengew. Bd. 4, p. 716; id. in Math. u. Naturw. Anz. Ung. Akad. Wiss. 52, 1935, p. 468 (*nom. tant.*).

I l l u s t r a t i o n s. FILARSZKY, *l. c.*, figs. 51—57; the pres. paper, f. 9*a*.

Differt ab varietate *Vieillardii* habitate tenuiori et rigidiori. *Caulis* ad 500 μ diam. *Verticillorum ramuli* 6—8, 1.5 cm longi, 0.5 mm diam., 4 articulationibus, segmento ultimo conico. *Bracteae* et *bracteoli* c. 90 μ longi.

Differs from variety *Vieillardii* by the more slender and the stiff habit. Diam. of the *stem* up to 500 μ. *Branchlets* (4—)6(—8) in a whorl, c. 1.5 cm long, 0.5 mm in diam., showing 4 articulations of which the ultimate one is cone-shaped. *Bract-cells* and *bracteoles* usually lacking, if any, up to 90 μ long.

SUMATRA: T a p a n o e l i, Lake Toba, S. W. part of the Porsea basin, from 3 m depth, alt. 900 m, 8 IV 1929, German Limnol. Sunda Exped. TP1d (Bu-Mus), *type*, mixed with the formalin and dried material of FILARSZKY's No. 4 (1934, p. 711), only oogonia are present and on the lowest nodes bulbils were found; ibid., Batakdistricts, 16 VII 1904, VAN DAALEN 539a (Bz, L), ♂ and ♀, together with *Chara fibrosa* ssp. *flaccida* and *C. zeylanica*.

V e r n a c u l a r n a m e: limoet (cf. lomotra, ZANEVELD, 1939, p. 376).

R e m a r k s. This form is to be distinguished from the typical form by the smaller habit and by having more branchlets in a whorl. The stipulodes and bract-cells are hardly developed or they are rudimentary as is the case in the specimens of the Sunda Expedition.

At the end of the type description of *Tolypellopsis simplicissima*, FILARSZKY (1934, pp. 716—717) states already that the plants from the

[1]) According to NORDSTEDT (1888, p. 188) NAUMANN is the collector.

Porsea-basin were quite identic with *Chara australis* R. BROWN. Only relying on KUETZING's figures (1857, pl. 27, f. 2, pl. 28, f. 1) and not on the specimens themselves, FILARSZKY concludes that *C. australis* and *C. Stuartiana* do not belong to the genus *Chara* but to *Nitellopsis* (= *Tolypellopsis*), and he rejects the correctness of the note in BRAUN & NORDSTEDT (1882, p. 109), where KUETZING's remark that the bract-cells are absent, is contradicted. In studying the same specimens as figured by KUETZING, it is without any doubt as I already pointed out (p. 126) that in those specimens the bract-cells are present. However, it is possible that they are lacking and this is the case in FILARSZKY's specimens. A close examination of FILARSZKY's *Tolypellopsis* (*Nitellopsis*) *simplicissima* leads me to the conclusion that it is a synonym of *Chara australis*, but it may be considered a separate form.

Ecology. The badly preserved specimens are densely covered with clay and therefore they look somewhat unusual. To the specimens from the Porsea-basin is added: temp. of surface 35°—27° C., pH 8.3, alkalinity 1.56, conductivity $1.33 \cdot 10^{-4}$. Other species of the same locality are *Chara fibrosa* ssp. *flaccida* and *C. zeylanica*.

Distribution. Between 2° N. and 3° N.; ASIA, Malaysia, Sumatra.

Var. *δ* **plebeja** A. BRAUN in Abh. Kön. Akad. Wiss. Berlin 1882, p. 107, pl. 7, f. 196; id. in LEHMANN's Plant. Preiss. 2, 1847, p. 148 — *Chara plebeja* R. BROWN *ined.*, ex A. BRAUN in Linnaea 17, 1843, p. 118; id. in HOOKER's Journ. Bot. 1, 1849, p. 201; KUETZING, Spec. Alg. 1849, p. 519; T. F. ALLEN, Charac. Americ. 1, 1888, p. 53 (*nom. tant.*); NORDSTEDT in Proc. Roy. Soc. Viet. 31, N. S., 1918, p. 4 (*nom. tant.*).

The terminal articulation of the branchlets is obtuse and not apiculate or acute.

Remarks. NORDSTEDT (1882, p. 107) states that BRAUN has cited this variety in his manuscript as "*γ plebeja*", however, on account of BRAUN's remark in Charac. Afrik. (1868, p. 799): "*Ch. australis* cum subsp.", NORDSTEDT has cited this variety in "Die Fragmente" as a subspecies. With regard to the characteristics and the Greek type *γ* I think that BRAUN may later on have considered it a variety and therefore I give it that rank. No specimens seen.

Distribution. Between 10° S. and 30° S.; AUSTRALIA: North coast, BRAUN (1843, p. 118), KUETZING (1849, p. 519), BRAUN & NORDSTEDT (1882, p. 107).

2. Chara Wallichii A. BRAUN in Abh. Kön. Akad. Wiss. Berlin, 1882, pp. 17, 107, pl. 7, figs. 197—198; id. in Monatsber. Kön. Akad. Wiss. Berlin f. 1867, p. 799, 1868 (*nom. tant.*); T. F. ALLEN, Charac. America 1, 1888, p. 53 (*nom. tant.*); J. GROVES in Journ. Linn. Soc., Bot., 46, 1924, pp. 363, 371; G. O. ALLEN in Journ. Bombay Nat. Hist. Soc. 30, 1925, p. 597, pl. 4; id. in Journ. Ind. Bot. Soc. 7, 1928, p. 60, f. 9; id. in Journ. Ind. Bot. Soc. 15, 1936, p. 52; PAL in Journ. Burma Res. Soc. 18, 1929, p. 113 (*nom. tant.*); id. in Journ. Linn. Soc., Bot., 49, 1932, pp. 65, 79, pl. 14—15

Plant dioecious, bright to brownish-green, 15—25 cm high. *Stem* stout, 875—1000 μ in diam. *Internodes* ½—1 times the length of the branchlets. *Cortex* and *spine-cells* absent. *Stipulodes* rudimentary. *Branchlets* 5—6 in a whorl, straight, c. 1.5 cm long, consisting of 4—6 articulations, of which the second is the longest, and the ultimate one the shortest, though somewhat longer than the surrounding bract-cell(s). *Bract-cells* cone-like, 4 at the lower nodes, 3, 2, and 1 or 2 at the next nodes, gradually diminishing in length; the lowest bract-cells are c. 1068 μ long and c. 356 μ wide at base, the ultimate one(s) 445 μ long and c. 223 μ wide at base. The terminal node usually contains one bract-cell, but those with two are also present. *Bracteoles* usually 3, similar to the bract-cells. ♂ and ♀ *gametangia* sessile, produced at the base of the branchlet-whorls as well as at all branchlet-nodes. *Antheridia* 1—3 together, 790—900 μ in diam. *Oogonia* clustered, 840—900 μ long (incl. coronula), 630—700 μ wide; *spiral-cells* showing 7—8 convolutions; *coronula* 140—155 μ high, 200—235 μ wide at base, persistent, straight; *oospores* black, c. 500—610 μ long, 380—440 μ wide with 6—7 prominent ridges terminating in short claws.

INDIA: Gangetic Plain, Pirgunj, 9 I 1809, without collector's name, ex herb. Ind. Orient. Soc. Linn. Lond. (B), ♂, fragments of the *type*.

Remarks. The other dioecious species of the ecorticate *Haplostephanae* are but two in number. Now *Chara fulgens* has the base of the branchlet-whorls sterile, whereas *C. Wallichii* can be distinguished from *C. australis* by its smaller gametangia, a well developed terminal branchlet-articulation, and macroscopically visible bract-cells. These characters may also serve in distinguishing this species from the monoecious *C. corallina*.

Ecology. In growth-form *C. Wallichii* is a large, robust plant, rather spiky in appearance and very brittle (ALLEN 1928, p. 60). The plants grow in dense clumps in which other species are never found. When the environmental conditions are favourable this species is able to oust other plants in a pond as PAL (1932, p. 53) writes, for *C. Wallichii* at Toungoo, Burma, obtained complete possession of a pond in which a little earlier a rich vegetation of reeds, *Nymphaea*, *Salvinia*, etc. was present. Though it thus occurs in stagnant water, the species is also found growing in water that has an appreciable current (ALLEN, 1925, p. 598).

The few records indicate that *C. Wallichii* has fully mature oogonia in December and January in Burma and from October to December in the Gangetic Plain. According to PAL (*l.c.*, p. 51) the species is restricted entirely to lowland country. As epiphytes are recorded *Coleochaete* and *Diatomeae* species.

Distribution. Between 30° N. and 19° N.; ASIA, India: Gangetic Plain. Moreover in lit.: India, Lower Burma, PAL (1931, p. 79).

3. Chara corallina WILLDENOW in Mém. Ac. Roy. Berlin f. 1803, p. 89, 1805; id. in Samml. d. Abh. Kön. Akad. Wiss. Berlin f. 1803, p. 61, 1806; id., Spec. Plant. 4, 1805, p. 186; BRUZELIUS & FUERNROHR in Flora 9, 1826, p. 491; BRAUN in HOOKER's Journ. Bot. 1, 1849, p. 294; KUETZING, Spec. Alg., 1849, p. 519; WALLMAN in Act. Soc. Linn. Bordeaux 21, 1856, p. 48; BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, pp. 17, 108; T. F. ALLEN, Charac. America 1, 1888, p. 53 (*nom. tant.*); H. & J. GROVES in Philipp. Journ. Sci. 7, 1912, p. 69; MERRILL,

Spec. Blancoan. 1918, p. 40; J. GROVES in Journ. Linn. Soc., Bot., 46, 1922, p. 102; id. in Journ. Linn. Soc., Bot., 46, 1924, pp. 363, 371; G. O. ALLEN in Journ. Bomb. Nat. Hist. Soc. 1925, p. 52; GROVES & STEPHENS in Trans. Roy. Soc. S. Afr. 13, 1926, p. 154; GROVES & ALLEN in Journ. Bot. 65, 1927, p. 338; G. O. ALLEN in Journ. Ind. Bot. Soc. 7, 1928, p. 61; PAL in Journ. Burma Res. Soc. 18, 1929, p. 113 (*nom. tant.*); id. in Journ. Linn. Soc., Bot., 49, 1932, pp. 65, 80; DIXIT in Journ. Ind. Bot. Soc. 14, 1935, p. 258; G. O. ALLEN in Journ. Ind. Bot. Soc. 15, 1936, p. 52; AGHARKAR & KUNDU in Journ. Dep. Sci., N.S. 1, 1937, p. 11 — *Chara congesta* SPRENG. var. P. Fr. ANTONIO LLANOS (non *C. congesta* R. BROWN = *N. congesta* A. BR.), Fragm. d. alg. plant. d. Filipinas, Manila 1851, p. 112 — *C. corallina* var.? *basilaris* A. BRAUN in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 108 — *Chara furcata* HORNEMANN, a name to be found on herbarium labels — *Chara moluccana* ZIPPELIUS in Herb. Lugd. Bat. — *Chara Roxburghii* A. BRAUN (non *N. Roxburghii* A. BR.) in Regensb. Bot. Zeit., 1835, p. 59 — *Nitella corallina* AGARDH, Syst. Alg., 1824, p. 123.

Illustrations. WILLDENOW in Mém. Ac. Roy. Berlin f. 1803, pl. 2, f. 2, 1805; id. in Samml. d. Abh. Kön. Akad. Wiss. Berlin f. 1803, pl. 2, f. 2, 1806; KUETZING, Tab. Phyc. 7, 1857, pl. 80; BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, pl. 7, f. 199; GROVES & STEPHENS in Trans. Roy. Soc. S. Afr. 13, 1926, pl. 14 (f. *mascarensis*); G. O. ALLEN in Journ. Ind. Bot. Soc. 7, 1928, f. 10 and pl. 6; AGHARKAR & KUNDU in Journ. Dep. Sci., N. S. 1, 1937, pl. 5, figs. 3—6; the pres. paper, f. 12*a*.

Plant monoecious, bright to brownish-green, slightly annularly incrustated, flexible, up to 30 cm high. *Stem* moderately stout, 750—1205 μ in diam. *Internodes* 1—4 times the length of the branchlets. *Cortex* and *spine-cells* absent. *Stipulodes* rudimentary, alternating with the branchlets, if any, small and acute, c. 210 μ long, c. 150 μ wide at base[1]). *Branchlets* 6—8 in a whorl, c. 3 cm long, consisting of 4—5 swollen articulations, contracted into the nodes, the ultimate articulation, however, cone-shaped, variable in size, 45—255 μ long, 30—105 μ wide at base, apex acute and somewhat incurved, penultimate cell rounded at apex. *Bract-cells* 3(—4), small, acute, up to 210 μ long, c. 60 μ wide at base, sometimes lacking at the ultimate branchlet-node. *Bracteoles*

[1]) In the HORNEMANN specimens extant in the Berlin herbarium (cf. also BRAUN, 1849, p. 295) the stipulodes have the extraordinary length of 750 μ and a breadth of 225 μ.

similar to the bract-cells or somewhat shorter, c. 150 μ long, c. 45 μ wide at base. ♂ and ♀ *gametangia* together (see remarks) in a great number at the base of the branchlet-whorls and solitary or geminate at the two lowest branchlet-nodes. *Antheridia* earlier ripe than oogonia, 530—675 μ in diam. *Oogonia* 925—1230 μ long (excl. coronula), 600—900 μ wide; *spiral-cells* showing 7—9 broad convolutions; *coronula* 150—180 μ high, 180—195 μ wide at base; individual cells in a young state diverging, when mature close together; *oospores* black, 645—875 μ long, 525—605 μ wide, with 6—7 ridges.

INDIA: Malabaria, Bombay, no date, POLYDORE ROUX s.n., ex herb. BOISVIN, com. GUILLEMIN (B); Coromandelia, Tranquebar, Wöppanpasi Tam, 7 I 1799, no collector's name, herb. G. VON MARTENS in (B), fragment of the *type* [1]); Bengal, without exact locality, 1869, c. KURZ 1924 (B); ibid., 1871, KURZ 2718(B); India orientalis, without indication of the locality and date, HORNEMANN s.n. (B); ibid., ex herb. LINK in (B); In Indiae aquis (KLEIN), without exact locality, date and collector's name, ex herb. WILLD., 1806—'12 (B), cf. BRAUN (1849, p. 295).

SIAM: Pak Raw, inside channel between two parts of Talé Sap, water 4—6 m, brackish, 25 I 1916, ANNANDALE 15 (Si), together with *Chara hydropitys* and *C. zeylanica*.

JAVA: Banjoemas, G. Dijéng (on the label: "Yang mount.") near Tamanhidoep, alt. 2200 m., VI 1928, GANDRUP s.n. (Bz), sterile and badly preserved specimen, therefore identification not certain.

BORNEO: W. Division, Bengkajang, III—IV 1863, Dr E. VON MARTENS s.n., ex herb. BRAUN in (B), "Unter *Nitella polyglochin* v. *Zollingeri*", four sterile specimens of which three have the remark "im Festungsgraben 22 - 3 - 63" and the fourth bears no annotations at all.

PHILIPPINE ISLANDS: without exact locality and date, LLANOS s.n., ex herb. DE CAND. 1855 in herb. A. BRAUN in (B), *type* of *Chara corallina* WILLD. var. *basilaris*, *C. congesta* LLANOS non R. BR. [2]).

---

[1]) BRAUN (1849, p. 295) states that WILLDENOW gives Malabar as the type locality, but KLEIN wrote on a paper in WILLDENOW's herbarium: "Frankenb. 1799" and therefore BRAUN supposed that this must be "Tranquebar" on the coast of Coromandel, which is actually confirmed by a specimen in the Berlin herbarium.

[2]) This is the specimen mentioned by BRAUN & NORDSTEDT (1882, p. 108), GROVES (1912, p. 69) and MERRELL (1918, p. 40). In contradistinction to BRAUN's remark (1882, p. 108) I saw on a branchlet-node of the type an antheridium and a young oogonium. The var. *basilaris* must therefore be excluded as it was based on the absence of this particular. This specimen undoubtedly is *C. corallina* and not *C. zeylanica* as MERRILL (1918, p. 40) presumed. On the same herbarium sheet there is another specimen with the following note: "*Chara furcata* ROXB., ex herb. DESFONTAINE". Most probably this specimen was not collected in the Philippines (cf. also BRAUN, 1849, p. 295).

AMBOINA: in the lake of the Governor's garden, no date, ZIPPELIUS s.n. (L), very rich fertile material, mixed up with *N. pseudoflabellata* var. *mutila* [1]).
NEW CALEDONIA: Wagap, 1863, VIEILLARD 1984 ?, ex herb. KUETZING in (L).

Remarks. The present species is in a marked degree protandrious. Ripe antheridia and oogonia are hardly to be found at the same time. There is an interesting difference in the situation of the gametangia at the branchlet-nodes in *C. corallina* and other *Chara* species. The place of the antheridium at the branchlet-nodes is not below the oogonium as is usually the case in the genus *Chara*, but it is more or less obliquely situated. This may go so far that it sometimes looks as if the antheridium is attached beside the oogonium.

This also explains the situation of the bracteoles. Frequently one bracteole is normally situated above the antheridium, whereas the other one stands below the antheridium at the side of the oogonium. As GROVES & STEPHENS (1926, p. 154) already stated, it is easily to be seen that the ♂ and ♀ gametangia both proceed from the same peripheral cell of the branchlet-node. In the genus *Lychnothamnus* the normal position of the ♂ and ♀ gametangia is side by side, but in that genus the ♂ and ♀ gametangia are produced by different cells of the branchlet-node.

KUETZING (1857, pl. 80, figs. a and b) figures "Früchte in den Winkeln der Involucralblätter" to which BRAUN (1882, p. 108) remarks: "Ich sah blosz Antheridien Auszerhalb". Though this is the case in by far the most specimens, the oogonia are sometimes inserted outside the whorls as is also figured by AGHARKAR & KUNDU (1937, pl. 5, f. 3) and by ALLEN (1928, f. 10b). The plate of GROVES & STEPHENS (1926, pl. 14) shows figures (i. e. 2, 4, 5) with very small oogonia which have already a well developed series of crown-cells, which is always the case in this species.

C. corallina belongs to the group of ecorticate haplostephanous *Charas* of which six other ones are also distributed in the same area, all easily distinguishable. *Chara australis*, *C. Wallichii* are dioecious, *C. nuda* has always solitary gametangia, and *C. Braunii* and *C. fulgens* do not have the aggregated gametangia at the base of the branchlets, whereas *C. succincta* has the oogonia at the base of the whorls only.

The species was hitherto not recorded from Australia, therefore the specimen of VIEILLARD in the Leiden herbarium is of interest.

The variety *basilaris* LLANOS must be excluded as the type speci-

[1]) ZIPPELIUS visited Amboina in 1828.

men has the gametangia at the branchlet-nodes too; the absence of this characteristic was the main subject for establishing this variety.

GROVES & STEPHENS (1926, p. 154) designated provisionally a form *mascarensis,* which can be distinguished from the type in having usually a ring of bract-cells surrounding the final articulation, and in having more numerous stipulodes. As I did not see the specimen, no comments can be given, but the cited differences from the type seems to be very inconstant so that I believe it hardly necessary to maintain the form.

Ecology. *C. corallina* is usually a very large and robust but brittle plant. It sometimes reaches a length of 50 cm when growing amongst a thick vegetation, as in this case the internodes in the lower parts of the plants are considerably elongated. Another peculiarity for this species is the more or less contracted nodes and the swollen branchlet-articulations. When dried and not heavily pressed the specimens show a marked rippling, possibly due to the annular lime incrustation as the not incrusted clear green parts are heavier shrivelled up than the parts provided with calcium carbonate. Though BRAUN (1849, p. 295) declines the annular incrustation for this species it is often described (cf. ALLEN 1928, p. 61 and PAL, 1932, p. 80), and was noticed by the writer too in different specimens.

The species grows in largish clumps, in the stagnant water of ponds, pools, etc., but also in the typical "raos", torrent beds of the Saharanpur district. In the Toba lake it is mixed up with *Nitella sumatrana* and *C. zeylanica,* in Amboina with *N. pseudoflabellata* and in Siam with *Chara hydropitys* and *C. zeylanica.*

Malaysian plants bearing gametangia are found from March to July, they are, in India, at their best throughout the cold weather (ALLEN 1928, p. 61).

Chara corallina is probably most represented in mountainous areas; in Sumatra and Java it occurs at an altitude of 2200 m.

It is very seldom overgrown with green algae. DIXIT (1935, p. 258) mentions *Chaetophora elegans* ROTH. as being epiphytic. A number of *Hydra* and *Vorticella* species are also present on the thallus.

The ripe antheridia have a coral-red colour to which the specific name refers; they are found from January to July.

Distribution. Between 25° N. and 25° S.; ASIA, India: Malabaria, Coromandelia, Bengal; Siam; Malaysia: Java, Borneo, Philippine Islands, Amboina — AUSTRALIA, New Caledonia. Moreover in lit.: ASIA, Ceylon (GROVES, 1921, p. 102); Gangetic Plain:

Saharanpur, GROVES & ALLEN (1927, p. 338), ALLEN (1928, p. 61); Bareilly, ALLEN (1936, p. 52); Gonda, GROVES (1934, p. 372), ALLEN (1925, p. 597); Benares, Howrah, Mugra, Sucksagur, Calcutta, GROVES (1924, p. 372); Pegu: Kyantaw (= Kyeik-tau?); Malaysia: S. Andaman Islands, GROVES (1924, p. 372); Sumatra, GROVES & STEPHENS (1926, p. 154), GROVES & ALLEN (1927, p. 338), DIXIT (1935, p. 258) — AFRICA, Mascarene Islands, Mauritius, GROVES & STEPHENS (1926, p. 154).

4. Chara fulgens FILARSZKY in Arch. f. Hydrobiol. 1934, Suppl. Bd. 12, Trop. Binnengew. Bd. 4, pp. 720; id. in Math. u. Naturw. Anz. Ung. Akad. Wiss. 52, 1935, p. 468 (*nom. tant.*).

Illustrations. FILARSZKY, 1934, *l. c.*, figs. 66—70; the pres. paper, f. 10*a*.

Plant dioecious, bright-green, glossy, hyaline, flexible, probably c. 30 cm high (and more). *Stem* rather robust, up to 1000 μ in diam. *Internodes* very variable in length with respect to the length of the branchlets: in the lower parts of the plants very long, 4—6 cm, in the upper parts, 0.5—2 cm. *Stipulodes* alternating with the branchlets, conical, acute, c. 180 μ long, c. 35 μ wide at base. *Branchlets* 4—8 in the upper whorls, 4—6 in the lower ones, 0.5—2 cm long, consisting of 4—6 articulations of which the ultimate one is short; they are swollen and constricted into the nodes. *Bract-cells* (1—)3(—4), equally small, acute, much shorter than the oogonia, c. 125 μ long, 45 μ wide. *Bracteoles* similar to the bract-cells. ♂ and ♀ *gametangia* disjuncted, solitary at the first and second branchlet-nodes. *Antheridia* unknown. Ripe oogonia not known. *Oogonia* c. 900 μ long (excl. coronula); *coronula* c. 175 μ high, c. 180 μ wide at base, individual cells strongly divergent and egg-shaped.

BALI: S. Bali, Danaubratan, little caldera lake near Batoeriti, alt. 1231 m, depth 10 m, 15 VI 1929, German Limnol. Sunda Exp. BB2a (Bu-Mus), *type*, two specimens with very few ♀ fragments.

Remarks. I hesitated somewhat to describe this plant as a separate species on account of the following. It is quite similar to *C. australis* var. *Vieillardii*, except the lack of oogonia at the base of the whorls, and it also resembles very much *C. Braunii*, except its being dioecious.

FILARSZKY's description of this species was only based on two ♀ whorls preserved in fluid. Though I borrowed from the Museum of Budapest all the material of the German Limnol. Sunda Exp. these fragments were not to be found in the tube BB2a: this contained

only fragments of *Nitella mucronata* var. *pseudograciliformis*, with which it was found growing together. In the dried material, however, I saw another ♀ whorl with unripe oogonia situated in the same manner, viz. only at the branchlet-nodes. Therefore, and also in view of the theoretical possibility of the existence of this species as a combination of characters I consider it a separate species.

Ecology. The bright-green robust plant has a glossy appearance. When dried it has an almost white colour, which is probably not due to a heavy incrustation as this was not at all observed. It was collected together with *Nitella mucronata* var. *pseudograciliformis* in a caldera lake with a diam. of 2.6 km at an elevation of 1230 m. Temperature of the surface 22.1° C., alkalinity 0.16, pH 6.8.

Distribution. 8° S.; ASIA, Malaysia: Bali.

5. Chara Braunii GMELIN[1]), Flor. Badens. Alsat. 4 (suppl.), 1826, p. 646; BISCHOFF, Krypt. Gew., 1828, p. 26; WALLMAN in Act. Soc. Linn. Bordeaux 21, 1856, p. 49; NORDSTEDT, Australas. Charac. 1, 1891 (no page); ROBINSON in Bull. New York Bot. Gard. 4, 1906, p. 258; H. & J. GROVES in URBAN, Symb. Antill. 7, 1911, p. 38; id. in Philipp. Journ. Sci. Bot. 7, 1912, p. 70; NORDSTEDT in Proc. Roy. Soc. Vict. 31, N. S., 1918, p. 5; J. GROVES in Journ. Linn. Soc., Bot., 46, 1924, pp. 363, 372; G. O. ALLEN in Journ. Bombay Nat. Hist. Soc. 30, 1925, p. 599; GROVES & ALLEN in Journ. Bot. 65, 1927, p. 338; G. O. ALLEN in Journ. Ind. Bot. Soc. 7, 1928, p. 61; GROVES & ALLEN in Proc. Roy. Soc. Queensl. 46, 1935, p. 55; DIXIT in Journ. Ind. Bot. Soc. 14, 1935, p. 258; G. O. ALLEN in Journ. Ind. Bot. Soc. 15, 1936, p. 51; AGHARKAR & KUNDU in Journ. Dep. Sci., N. S. 1, 1937, p. 12 – *Chara coronata* ZIZ. (ined., c. annum 1814); BISCHOFF, Krypt. Gew. 1828, p. 26; WALLROTH, Flor. Crypt. Germ., 1833, p. 107; BRAUN in Flora 18, 1835, p. 59; GANTERER, Oesterr. Charen, 1847, p. 13; BRAUN in Schweiz. Charac., 1849, p. 13; id. in HOOKER's Journ. Bot. 1, 1849, p. 295; KUETZING, Spec. Alg. 1849, p. 520; A. BRAUN, Consp. syst. Charac. europ., 1867, p. 4; id. in Monatsber. Kön. Akad. Wiss. Berl. f. 1867, p. 897, 1868; T. F. ALLEN in Americ. Natur. 16, 1882, p. 358; A. BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, pp. 17, 108; NORDSTEDT in Acta Univers. Lund 25, 1889, p. 32; MIGULA, Syn. Charac. europ. 1898, p. 72; DE WILDEMAN, Alg. Fl. Buitenz., 1900, p. 372; MIGULA

[1]) From Europe only the principal papers are cited, for further literature cf. MIGULA, Die Charac. Deutschl., 1897, p. 321 and GROVES & BULLOCK WEBSTER, The British Charoph. 2, 1924, p. 11.

in Hedwigia 70, 1931, p. 215 — *Nitella Braunii*; *Charopsis Braunii*; *Chara oahuensis*; *Chara coronata* var. *Junghuhniana*, var. *leptosperma*, var. *leptosperma* f. *javanica*, var. *leptosperma* f. *oahuensis*, var. *Meyenii*, var. *oahuensis*, var. *orientalis*, var. *pachysperma* f. *leptocoronulata*, cf. varieties.

Illustrations. Bischoff, Krypt. Gew., 1828, pl. 1, figs. 5, 7; Kuetzing, Tab. Phyc. 7, 1857, pl. 43, f. 1; T. F. Allen in Americ. Natur. 16, 1882, figs. 1—11; Nordstedt, Australas. Charac. 1, 1891, pl. 7, figs. 1—6; G. O. Allen in Journ. Bombay Nat. Hist. Soc. 30, 1925, pl. 3; id. in Journ. Ind. Bot. Soc. 7, 1928, f. 11; Agharkar & Kundu in Journ. Dep. Sci., N.S. 1, 1937, pl. 5, figs. 7—10, pl. 6, figs. 1—14.

Plant monoecious, bright-green, up to 35 cm high, smooth and flexible, therefore *Nitella*-like, not at all incrustated. *Stem* rather slender, c. 500 μ in diam. *Internodes* variable in length, usually as long as the branchlets or somewhat shorter. *Cortex* and *spine-cells* absent. *Stipulodes* in a single whorl, as numerous as the branchlets and alternating, c. 475 μ long, c. 130 μ wide, acute. *Branchlets* 8—11, up to 3.5 cm long, consisting of 4—6 articulations, the lower 3—5 elongate, the ultimate very short. *Bract-cells* 3—4, small, acute, 330 μ long, 75 μ wide, at the terminal node forming together with the small terminal articulation a 3—5-celled corona-like termination; posterior bract-cell(s) very short or lacking, anterior ones about equalling the oogonium, rarely longer, often shorter. *Bracteoles* usually somewhat longer than or equal to the oogonia, similar to the anterior bract-cells. ♂ and ♀ *gametangia* at the first, second or third lowest node but not at the base of the branchlet-whorls, solitary, seldom double or triple, at the same nodes. *Antheridia* 225—415 μ in diam. *Oogonia* c. 750 μ long, c. 500 μ wide; *coronula* much varying in height (80—225 μ); *spiral-cells* showing 8—13 convolutions; *oospores* black, 425—750 μ long, 300—575 μ wide; with 7—12 inconspicuous ridges.

Remarks. A peculiarity of this species is the extremely short terminal articulation of the branchlet. This articulation has nearly the same length as the surrounding bract-cells giving the termination of the branchlets a crowny appearance; hence the synonymic name *coronata*.

Concerning this species there are some nomenclatural questions demanding a solution now. Groves & Bullock Webster (1924, p. 14) already pointed out that Gmelin's name "*Braunii*" has to be used for the species as it has date priority over the name "*coronata*" of Braun

himself. The same is the case with some names of varieties and forms published by BRAUN. It will be seen below that the frequently used varietal name *leptosperma* A. BRAUN is invalid and must make way for MEYEN's name "*oahuensis*". Below, these matters are discussed in extension for the forms.

The following table gives a survey of the varieties known at present, together with their principal characters.

TABLE XIII.

Characters / Varieties of *C. Braunii* GMEL.	Length of oospore in μ	Number of ridges	Length of ant. bract-cells with respect to length oogon.	Situation of bract-cells	Shape of coronula cells
Braunii (A. BR.) ZANEV.	420—550	9	equal or shorter	unilateral or verticillate	short, obtuse
Schweinitzii (A. BR.) ZANEV.	550—650	9	longer	verticillate	short, obtuse
Kurzii ZANEV.	650—700	9	longer	verticillate	short, obtuse
Perrottetii (A. BR.) ZANEV.	600—650	9—10	equal	unilateral	short, obtuse
coromandelina (A. BR.) ZANEV.	500—550	7—8	equal	verticillate	short, obtuse
oahuensis (MEYEN) ZANEV.	600—750	10—12	equal or shorter	verticillate	elongate

Chara Braunii is a cosmopolitan species and therefore we may expect a good number of varieties and forms influenced by the different conditions of the environment. However, as T. F. ALLEN (1888, p. 359) already states, it is an interesting fact that the plant in any given locality is constant in its characters, and "though thousands of plants be examined they will all be found to exhibit precisely the same character". This is clearly shown in the form *javanica* occurring on the Dijèng plateau and first collected by JUNGHUHN c. 1840 and again by FEUERHORN in 1929. Both plants are quite identic in spite

of the long lapse of time. Therefore the discrimination of the more remarkably constant varieties and forms is very correct. And if we make use of the classification of T. F. ALLEN (1888, p. 361) who emphasizes the dimensions of the oospores and of the bract-cells, we cannot reject the earlier published names, but we have to bring them into accordance with his really good survey though it is only useful if one disposes of fertile plants with ripe oospores. Therefore I have added below to the description of each form a diagnosis in terms of ALLEN's classification. A definite subdivision of the species into varieties and forms can only be given by a monographer who has examined all the material.

The fact that *C. Braunii, C. pashanii* and *C. nuda,* in contradistinction to the likewise monoecious *C. corallina,* have no gametangia at the base of the branchlet-whorls is noteworthy, as it is a remarkable point of discrimination between these species and *C. corallina.* From *C. pashanii* and *C. nuda* it is mainly distinguished in having a corona-like termination to the branchlets and fairly well-developed stipulodes.

Ecology. *C. Braunii* is a medium-sized plant, often tufted in growth and very glossy (f. *javanica*). The clear green ecorticate stems and branchlets give it a *Nitella*-like appearance. Incrustation is but seldom present and then annular in character.

The species is distributed in all the continents and therefore much variable in habit. In the warmer regions it is restricted to mountainous areas: in the western Himalayas it occurs at an elevation of c. 1800 m, on Mt. Dijèng, Java, at an altitude of c. 1880 m, on Mt. Rindjani, Lombok, at 2000—2400 m.

C. Braunii is found in the stagnant water of ditches, lakes, large patches, etc., from November to May with ripe oospores. Especially the occurrence in the regions of solfataras is of interest. It is but seldom found growing mixed up with other *Charas* or phanerogamic aquatic plants. *Spirogyra setiformis* is often present between the branchlets.

The pH is only measured in Lake Toba, where it was 7.5.

Distribution. Between 65° N. and 35° S.; ASIA, India; Indo-China; Malaysia — AUSTRALIA, Hawaiian Islands; cf. varieties. Moreover in lit.: EUROPE, cf. MIGULA (1897, p. 331), GROVES & BULLOCK WEBSTER (1924, p. 13) — ASIA, Siberia, RUPRECHT (1845, p. 12); Japan, BRAUN & NORDSTEDT (1882, p. 113), MIGULA (1931, p. 215); China, BRAUN & NORDSTEDT (1882, p. 109); India:

Malabaria, DIXIT (1935, p. 258), Gangetic Plain, GROVES (1924, p. 372), ALLEN (1925, p. 599; 1928, p. 61; 1936, p. 51); Assam, Burma, GROVES (1924, p. 372); Malaysia: Philippine Islands, GROVES (1912, p. 70) — AMERICA, N. Am.: Canada, cf. var. *Braunii*; United States, BRAUN & NORDSTEDT (1882, pp. 110—112), ROBINSON (1906, p. 259); C. Am.: Mexico, cf. var. *Braunii*, St. Domingo, GROVES (1911, p. 38); S. Am.: Argentine, NORDSTEDT (1888, p. 188) — AFRICA, N. Afr.: Algeria, Senegambia, BRAUN (1868, p. 827); Egypt, cf. var. *Braunii*; Bogos Distr., BRAUN (1868, p. 827); S. Afr.: Cape Colony, NORDSTEDT (1889, p. 32); Mozambique, BRAUN (1868, p. 827) — AUSTRALIA, N. Austr.: Queensland, NORDSTEDT (1889, p. 32; 1891, no page), GROVES & ALLEN (1935, p. 55); S. Austr.: New South Wales, NORDSTEDT (1888, p. 188; 1889, p. 32); Victoria, NORDSTEDT (1889, p. 32; 1891, no page).

var. *α* **Braunii** (A. BRAUN) ZANEV., nov. comb. — *Chara coronata* ZIZ. var. *Braunii* A. BRAUN in HOOKER's Journ. Bot. 1, 1849, p. 296, *pro parte*.

Plant medium-sized. *Branchlets* 8—10 in a whorl, consisting of 4—5 articulations, the lower 3—4 elongated. *Bract-cells* unilateral or verticillate; posterior bract-cells always very short or rudimentary, anterior ones equal or shorter than the oogonium. *Bracteoles* resembling the anterior bract-cells, but frequently somewhat longer. ♂ and ♀ *gametangia* 1—3 together at the lowest two or three branchlet-nodes. *Oospores* 420—550 μ long, with 9 ridges. *Coronula* short and obtuse, up to 150 μ high.

Remarks. The typical variety of the species is characterized by the small oospore, the low number of ridges, and the small bract-cells, being shorter than the oogonium.

Distribution. Between 65° N. and 20° N:; ASIA, India, Malaysia, cf. formae. Moreover in lit.: EUROPE, cf. species — ASIA, Syria, cf. f. *typica* — AMERICA, Canada, United States, Mexico, cf. f. *typica* — AFRICA, Egypt, cf. f. *typica*.

f. 1. **typica** ZANEV., nov. form. — *Chara coronata* ZIZ. var. *Braunii* A. BRAUN in HOOKER's Journ. Bot. 1, 1849, p. 296; id., Consp. syst. Charac. europ., 1867, p. 4; BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 108; T. F. ALLEN in Amer. Nat. 18, 1882, p. 358; MIGULA, Die Charac., 1897, p. 321 — *Chara coronata* ZIZ. ined., c. 1814; KUETZING, Spec. Alg., 1849, p. 520; A. BRAUN in COHN's Krypt. Fl. Schles. 1, 1876, p. 403 — *Chara Braunii* GMELIN, Fl. Bad. Alsat. 4, Suppl. 1826, p. 646; ROBINSON in Bull. New York Bot. Gard. 4, 1906, p. 258; GROVES & BULLOCK WEBSTER, Brit. Charoph. 2, 1924, p. 11 — *Chara coronata*

Ziz. ssp. *Braunii* A. Braun in Ann. Sci. Nat. 2, 1834, p. 353; id. in Flora 18, 1835, p. 59; id. in Monatsber. Kön. Akad. Wiss. Berlin f. 1867, p. 826, 1868 — *Charopsis Braunii* Kuetzing, Phyc. Gen., 1843, p. 520; id., Phyc. germ., 1845, p. 257; Hy in Bull. Soc. bot. France 60, Mém. 26, 1913, p. 25 — *Nitella Braunii* Rabenhorst, Deutschl. Krypt. Flor. 2, 1847, p. 197.

Illustrations. Groves in Journ. Bot. 22, 1884, pl. 242; Migula, Die Charac., 1897, figs. 81—82; id., Syn. Charac. europ., 1898, figs. 68—69; Groves & Bullock Webster, Brit. Charoph. 2, 1924, pl. 26.

Verticillorum ramuli 8(—10), 4—5 articulationibus earum 3—4 inferiores elongatae. *Bracteae* 3—4, unilaterales. ♂ et ♀ *gametangia* ad tries nodos inferiores. *Oosporae* 420—500 μ longae, plerumque geminatae valde trinae, 8—9 striatae.

Branchlets 8(—10), consisting of 4—5 articulations, the lower 3—4 elongated. *Bract-cells* 3—4, unilateral. ♂ and ♀ *gametangia* usually geminate, occasionally three together, at the lower three nodes. *Oospores* 420—500 μ long, with 8—9 ridges.

India: W. Himalaya, Naini Tal, Kumaon, no date, Strachey & Winterbottom s.n., Himalayan herb. in herb. J. D. Hooker (B), determination not certain.

Remarks. The Naini Tal plant is provisionally placed here as I did not see the type of forma *eremosperma* (Rupr.) Zanev. (= f. *songarica* A. Br.) to which it probably belongs according to Braun (1882, p. 110). However, the number of striae is the same as in the var. *Perrottetii*, viz. 9—10, whereas the ripe oospores in the contrary are 420—475 μ long and 284—330 μ wide, also much shorter than is cited in the type description of *eremosperma*. Bract-cells verticillate though the posterior bract-cells are very short and the anterior ones are equal or shorter than the oogonia. Stipulodes 490—535 μ long, 117—135 μ wide. Oogonia geminate or triple. Braun has probably seen another specimen as he cites that the altitude is 6,500 feet. This note is not to be found on the label of the badly preserved fragments studied by me. The reason of the change of the name *songarica* is discussed under the forma *javanica*.

Distribution. Between 65° N. and 20° N.; Asia, India: W. Himalaya. Moreover in lit.: Europe, cf. Migula (1897, pp. 331—332), Groves & Bullock Webster (1924, p. 13) — Asia: Syria, Braun & Nordstedt (1882, p. 109) — America, N. Am.: Canada, North Carolina; C. Am.: Mexico, Missouri plains, Braun & Nordstedt

(1882, p. 110) — AFRICA, N. Afr.: Oase Dachel, BRAUN & NORDSTEDT (1882, p. 109).

f. 2. **sumatrensis** ZANEV., nov. form. — *Chara coronata* ZIZ., FILARSZKY in Arch. Hydrobiol. 1934, Suppl. Bd. 12, Trop. Binnengew. 4, p. 717.

Verticillorum ramuli 10, articulationes 4—5 (3—4 elongatae), c. 2 cm longae. *Bracteae* 3—4, verticillatae, 2 anteriores oogoniis aequilongae, 2—1 posteriores breviores. ♂ et ♀ *gametangia* solitaria ad nodos 2—3 inferiores. *Oosporae* 490—535 μ longae, 8—9 striatae.

Branchlets 10, consisting of 4—5 articulations of which 3—4 are elongated, c. 2 cm long. *Bract-cells* 3—4, verticillate, 2 anterior ones as long as the oogonia, 2—1 posterior ones shorter. ♂ and ♀ *gametangia* at the lower 2—3 branchlet-nodes, solitary. *Oospores* 490—535 μ long, with 8—9 ridges.

SUMATRA: East coast, Mt. Piso Piso, in a swamp, alt. 500 m, 28 II 1923, LÖRZING 9491 (Bz), *type*, cult. in the Bot. Garden Sibolangit; ibid., Bot. Garden Sibolangit, 24 IX 1923, LÖRZING 10165 (Bz), cult. from Mt. Piso-Piso material 9491; Tapanoeli, border of Lake Toba, spring-marsh, alt. c. 1250 m, in the valley of the A. Bong-Bong, 9 IV 1929, German Limnol. Sunda Exped. TBo3, TBo3c (Bu-Mus).

Remarks. This form has the usual small oospore with the number of striae peculiar to the var. *Braunii*, but in the situation of the bract-cells there is an interesting difference. Whereas in all described forms the bract-cells are unilaterally situated at the branchlet-nodes, they are verticillate in the present form. BRAUN states (1882, p. 110) that he American form *longifolia* has verticillate bract-cells only at the lowest branchlet-nodes, in the other ones, however, they are unilateral. It must be noted that in the Naini Tal plant the bract-cells are also verticillate, but that specimen has more ridges. In this form the coronula-cells are connate for the greater part, only the tops of the cells are strongly divergent. In the Mt. Piso-Piso material the coronula-cells have a height of 140 μ, and in the Toba specimens of 90 μ.

According to T. F. ALLEN (1888, p. 361) the form may be described as: forma *microcarpa, microptila, verticillata, subpachygyra, laxior*.

Ecology. The branchlets of the form *sumatrensis* show a distinct annular incrustation. The plants are overgrown with *Spirogyra setiformis* (ROTH) KUETZ. Other available data of the Toba specimens are: temperature 22°.3, pH 7.5, alkalinity $2.86 . 10^{-4}$.

Distribution. 2° N.; ASIA, Malaysia: Sumatra.

var. β **Kurzii** ZANEV., nov. var. — *Chara coronata* ZIZ. var. *coromandelina* A. BRAUN in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 112, *pro parte*.

Planta major. *Caulis* ad 1000 μ diam. *Verticillorum ramuli* 9, articulationes 5—6 (4—5 elongatae). *Bracteae* 3, oogonium bis superantes, acutissimae. *Gametangia* solitaria ad nodos 2 inferiores. *Oosporae* 640—694 μ longae, 9 striatae. *Coronula* brevis, erecta.

Plant probably robust, brown-yellow-green, covered with clay. *Stem* diam. c. 1000 μ. *Branchlets* 9 in a whorl, c. 2 cm long, of 5—6 articulations of which 4—5 are elongated and the last one is equal in length to the surrounding bract-cells. *Stipulodes* c. 890 μ long and 220 μ wide. *Bract-cells* 3, all very much elongated, twice as long as the oogonia, already visible with the naked eye, 215—240 μ wide, ending in a sharp point, posterior bract-cell frequently somewhat shorter than the oogonium. *Bracteoles* similar to the anterior bract-cells. ♂ and ♀ *gametangia* solitary, but together at the two lowest nodes. Oogonia 712—757 μ long (excl. coronula), 472—498 μ wide; *spiral-cells* showing 9—10 convolutions; *coronula* c. 90 μ high, 150—178 μ wide at base, individual cells connate except the ultimate blunt tops; *oospores* black, 640—694 μ long, 392—435 μ wide with 9 narrow ridges.

INDIA: Gangetic Plain, Behar, no date, J. D. HOOKER s.n. (B), sterile specimen; Bengal, without exact locality, 1869, SULP KURZ 1925 (B), *type*.

Remarks. The outstanding features of this variety are the extraordinary length of the oospores together with the low number of ridges, and the large bract-cells being twice as long as the oogonia.

In contradistinction to BRAUN's remark (1882, p. 113), I found the oogonia never geminate. In T. F. ALLEN's terminology the plants are characterized as: forma *macrocarpa, macroptila, verticillata, subpachygyra, condensata*.

The Behar specimen bears the following remark by BRAUN: "*Ch. coronata* var. *coromandelina* (*Ch. involucrata* ROXB.)". As I pointed out under the var. *coromandelina* (cf. p. 145) it is my opinion too that *C. involucrata* is a synonym of the var. *coromandelina*; but the specimen on which BRAUN wrote this note belongs to the new var. *Kurzii*.

Distribution. Between 22° N. and 25° N.; ASIA, India.

var. γ **coromandelina** (A. BRAUN) ZANEV., nov. comb. — *Chara coronata* ZIZ. var. *orientalis* A. BRAUN in HOOKER's Journ. Bot. 1, 1849, p. 295, *pro parte* — *Chara coronata* ZIZ. var. *coromandelina* A. BRAUN in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 112, *pro parte* —

? *Chara involucrata* ROXBURGH, Fl. Indica, 3, 1832, p. 565; id. repr. 1874, p. 648.

Plant rather robust, brownish green, less *Nitella*-like than var. *Braunii*, up to 20 cm high, covered with clay. *Branchlets* ± 8 in a whorl, c. 1.5 cm long, consisting of 4—5 articulations of which 3—4 are elongated, the last one being as long as the surrounding bract-cells. *Bract-cells* 3, as long as the oogonia, anterior and posterior ones equally developed, 90—130 μ wide. *Bracteoles* usually somewhat longer than the oogonia. *Stipulodes* elongate, c. 800 μ long, c. 150 μ wide. ♂ and ♀ *gametangia* solitary and together at the two lowest nodes. *Oogonia* up to 625 μ long (excl. coronula), c. 418 μ wide; *spiral-cells* showing 8—9 convolutions; *coronula* c. 150 μ high, c. 222 μ wide at base, individual cells not spreading, egg-shaped with a blunt top; *oospores* black, 500—550 μ long, c. 356 μ wide with 7—8 thick prominent ridges.

INDIA: Coromandelia, Carnetic, Gengu, in a swamp, 1826—'28, BÉLANGER s.n., Herbier de l'Inde 94 (B), *type*; ibid., Bengal, without exact locality and date, KURZ 2752 (B).

INDO-CHINA: Tonkin, in a river between Làng Dò and Cho Gidi, 12 X 1883, BON 2370 (P).

Remarks. The rather robust plant is characterized by a "large" oospore and a few number of ridges. However, I found the ripe oospores never longer than 550 μ, in contradistinction to T. F. ALLEN (1882, p. 358) who mentions 600—750 μ as the length. The size of the oospores have never been published, therefore I gave them above. BRAUN (1882, p. 112) cites the stipulodes as short, but they are as long as 800 μ. In the dried specimens the internodes are somewhat swollen, and contracted into the nodes.

According to T. F. ALLEN's terminology (1882, p. 361) the type may be described as: forma *meiocarpa, meioptila, verticillata, pachysperma, laxior.*

The different views with regard to the size are probably due to BRAUN, who mentiones in the "Fragmente" (1882, p. 113) three specimens, of which only two have the characteristics given in the type description (1849, p. 295). These two specimens are quoted above in the exsiccatae. The third specimen, however, KURZ 1925, does not belong to this variety, as it has much larger oospores with more ridges. This specimen is now described under the new variety *Kurzii*.

The description of var. *coromandelina* closely resembles that of *Chara involucrata* ROXBURGH (1832, p. 565; 1874, p. 648), however, as I did not see the original specimen the identity is not certain. If they

are synonyms, then var. *coromandelina* has to be named *involucrata* as that name has the priority.

The type specimen was mixed up with *Chara zeylanica*.

Distribution. Between 25° N. and 15° N.; Asia, India; Indo-China.

var. δ **oahuensis** (Meyen) Zanev., nov. comb. — *Chara oahuensis* Meyen, Reise um die Erde 2, 1835, p. 131, *pro parte* — *Chara coronata* Ziz. var. *leptosperma* A. Braun in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 112; de Wildeman, Prodr. Fl. Alg. Ind. Néerl., 1896, p. 96; id., Alg. Fl. Buitenz., 1900, p. 373.

Plant slender, elongate to compact, tufted; up to 20 cm high. *Stem* c. 800 μ in diam. *Internodes* ½—2 times the length of the branchlets. *Branchlets* 8—10 in a whorl, consisting of 4—6 articulations, the lower 3—4 elongate, 1.5—3 cm long, ultimate articulation short, hardly longer than the surrounding bract-cells; penultimate articulation sometimes also short. *Bract-cells* 3—4, unilateral or verticillate, very narrow, up to the same length as the oogonium. *Bracteoles* 2, slightly longer than the oogonium. ♂ and ♀ *gametangia* together at the lowest three nodes. *Coronula* very much elongated, 140—225 μ high; individual cells divergent, very wide and connate at base, above their middle abruptly narrowed, and ending into a blunt top. *Oospores* 600—750 μ long, with 11—12 ridges.

Java: Priangan, near Bandoeng, in lake Telaga Patengan, no date, Junghuhn s.n., ex herb. van den Bosch (L), without ripe oospores, therefore identification uncertain; ibid., Poentjak, in a ditch at the road-side, c. 1350 m alt., 5 I 1894, von Schiffner s.n. (L), immature, therefore identification uncertain.

Lombok: E. Lombok, Rindjani mountains (N. side), no date, Elbert 1192a (L), no ripe oospores, therefore uncertain; ibid., Rindjani Caldera, Poetih valley, 2000—2400 m alt., 6 V 1909, Elbert 1193 (L), without ripe oospores, therefore uncertain.

Remarks. This variety can be divided into three more or less distinct forms. The above cited exsiccatae are not to be classified into one of these forms as they are immature.

Var. *oahuensis* was established by Braun in 1849, when he did not think it right to keep up Meyen's *Chara oahuensis* as a distinct species and he therefore described it as a variety of *Chara coronata*. However, in 1882 Braun published a new variety *leptosperma* which was subdivided into three forms, one of these being *oahuensis*. This is in contradiction to the now adopted Nomenclatural Rules, reason why I have re-established the earliest published name. The type specimen is placed in the form *typica*.

Distribution. Between 21° N. and 8°.30′ S.; ASIA, Malaysia; Hawaiian Islands, cf. forms.

f. 1. **typica** ZANEV., nov. form. — *Chara oahuensis* MEYEN, Reise um die Erde 2, 1835, p. 131; KUETZING, Tab. Phyc. 7, 1857, p. 32; H. & J. GROVES in URBAN, Symb. Antill. 7, 1911, p. 38 — *Chara coronata* ZIZ. var. *oahuensis* A. BRAUN in HOOKER's Journ. Bot. 1, 1849, p. 296; T. F. ALLEN in Amer. Nat. 16, 1882, p. 361 — *Chara coronata* ZIZ. var. *Meyenii* A. BRAUN in Monatsber. Kön. Akad. Wiss. Berlin, f. 1867, p. 827, 1868 — *Chara coronata* ZIZ. var. *leptosperma* A. BRAUN f. *oahuensis* (MEYEN) A. BRAUN in Abh. Kön. Akad. Wiss. Berlin 1882, p. 113; NORDSTEDT, Australas. Charac. 1, 1891 (no page); LEMMERMANN in ENGLER's Bot. Jahrb. 34, 1905, p. 635; MACCAUGHEY in Bot. Gaz. 65, 1918, p. 136.

Illustrations. KUETZING, Tab. Phyc. 7, 1857, pl. 79, f. 2; NORDSTEDT, Australas. Charac. 1, 1891, pl. 7, figs. 7—8.

Planta tenuis, elongata, ad 18 cm alta. *Caulis* c. 800 μ diam. *Stipulodia* elongata, c. 445 μ longa. *Verticillorum ramuli* 8, 3 inferiores articulationes elongatae; segmenta ultima et penultima bracteis oogonioque circiter aequilonga. *Bracteae* 3—4, verticillati, anteriores circiter dimidio oogonii aequilongae, posteriores inchoatae, interdum brevissimae. *Bracteolae* 2, bracteis anterioribus aequales. *Coronula* elongata, c. 222 μ longa.

Plant slender, elongate, c. 18 cm high. *Stem* c. 800 μ in diam. *Stipulodes* long and slender, c. 445 μ. *Branchlets* usually 8 in a whorl, up to 1.5 cm long, the lower three articulations elongated; ultimate and penultimate articulations hardly longer than the surrounding bract-cells. *Bract-cells* 3—4, verticillate, anterior ones as long as or shorter than the oogonium, posterior ones much shorter or hardly developed. *Bracteoles* 2, similar to the anterior bract-cells. *Oogonia* 750—810 μ long (excl. coronula), 430—535 μ wide; *spiral-cells* showing 11—13 convolutions; *coronula* c. 222 μ high, 240 μ wide at base; *oospores* black, c. 667 μ long, c. 356 μ wide, with 11—12 inconspicuous ridges. *Antheridia* 400 μ in diam., earlier ripe than oogonia.

HAWAIIAN (SANDWICH) ISLANDS: Oahu, V 1831, MEYEN s.n. (B, *type*; L, cotype).

Remarks. As far as I am aware the exact dimensions of the type specimen have never been given; therefore I have cited them in the diagnosis of this form. F. *javanica* resembles much f. *typica*, but it is more compact, the stipulodes are c. 267 μ long, and the coronula shorter than 200 μ.

Distribution. 22° N.; Hawaiian Islands.

f. 2. **javanica** (A. BRAUN) ZANEV., nov. comb. — *Chara coronata* ZIZ. var. *Junghuhniana* A. BRAUN M. S. 1849, in herb. (B, K, L) — *Chara coronata* ZIZ. var. *orientalis* A. BRAUN in HOOKER's Journ. Bot. 1, 1849, p. 295, *pro parte* — *Chara coronata* ZIZ. var. *leptosperma* A. BR. f. *javanica* A. BRAUN in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 113; DE WILDEMAN, Prodr. Flor. Alg. Ind. Néerl., 1897, p. 30; id. Suppl. et Tabl. Stat., 1899, p. 96; id., Alg. Flor. Buitenzorg, 1900, p. 373; FILARSZKY in Arch. Hydrobiol. 1934, Suppl. Bd. 12, Trop. Binnengew. Bd. 4, p. 719.

Illustrations. FILARSZKY, Arch. Hydrobiol. 1934, Suppl. Bd. 12, Trop. Binnengew. Bd. 4, figs. 63—65; the pres. paper, figs. 16*a*—*d*.

Plants flexible, glossy, very much congested. *Branchlets* compact, incurved, up to 1.5 cm long with 3—4 elongated articulations. *Bract-cells* 3, verticillate, anterior cells shorter than the oogonium, posterior one very short, but seldom lacking. *Coronula* 133—222 μ high, individual cells for the greater part not contiguous, only connate in the lower parts, blunt at their tips.

JAVA: without exact locality and date, "No. 1 *Chara*", SPORLEDER s.n. (B), *type*; Banjoemas, G. Dijèng, "In lacubus planitiei", 1880 m alt., III—IV, no year, JUNGHUHN s.n., ex herb. VAN DEN BOSCH in (L), two specimens with a subscription by JUNGHUHN: "*vulgaris*"; ibid., "ex aquis stagnantibus et lente fluentibus planitiei", alt. 1890 m, III—IV, no year, JUNGHUHN s.n. (B, K, L), in total 17 specimens with a note by BRAUN: "*Chara coronata* ZIZ. var. *Junghuhniana*"; ibid., "in aquis planitiei", 1880 m. alt, JUNGHUHN s.n. (B), ex herb. C. VAN DEN BOSCH 1858; ibid., Dijèng plateau, Kawah pool in a region of solfatara's, German Limnol. Sunda Exp. FD2, 3 VI 1929, FEUERHORN s.n. (Bu-Mus).

Remarks. The outstanding features of this form are the compact habit and the glossy appearance. The stipulodes are less developed.

The type specimen consists of some fragments of fertile plants only. The *oogonia* are 756—845 μ long (excl. coronula), 500—540 μ wide showing 11—13 inconspicuous convolutions; *coronula* 150—180 μ high, 240—268 μ wide at base; *oospores* black, 680—740 μ long, c. 450 μ wide with 10 ridges. *Stipulodes* c. 267 μ long, 26—44 μ wide. *Antheridia* c. 356 μ in diam.

In following T. F. ALLEN (1882, p. 361)this form may be described as: forma *macrocarpa, microptila, verticillata, leiopyrena, clausa.*

BRAUN mentions in the "Fragmente" (1882, p. 113) "*Chara* No 1 SPORLEDER" as the type specimen of *C. coronata* var. *leptosperma* f. *javanica.* But the same specimen was already quoted by him (1849,

p. 296) as belonging to the var. *orientalis*. However, BRAUN cites in this last article *Chara eremosperma* RUPRECHT as a synonym of var. *orientalis*. The latter, on the other hand, is not mentioned at all in the "Fragmente", but there *C. eremosperma* is cited as a synonym of *Chara coronata* ZIZ. *α Braunii* A. BR. f. *songarica* A. BR. (1882, p. 109).

This leads me to the following conclusions:

1. the name of the var. *orientalis* is invalid and has to be named *eremosperma* (RUPRECHT) A. BRAUN;
2. the var. *orientalis* seems to comprise two different plants, *a.* one of these has later been described as forma *songarica* A. BRAUN, instead of which the name *eremosperma* (RUPRECHT) A. BR. has to be used, *b.* the other one is cited as belonging to *C. coronata* ZIZ. var. *leptosperma* A. BR. f. *javanica* A. BR., for which it is made clear above that it now must bear the name *C. Braunii* GMEL. var. *oahuensis* (MEYEN) ZANEV. f. *javanica* (A. BRAUN) ZANEV.
3. the var. *orientalis* A. BR. must be excluded.

Distribution. 7°30′ S.; ASIA, Malaysia: Java.

f. 3. **leptocoronulata** (FILARSZKY) ZANEV., nov. comb. — *Chara coronata* ZIZ. var. *pachysperma* A. BRAUN apud FILARSZKY f. *leptocoronulata* FILARSZKY in Arch. Hydrobiol. 1934, Suppl. Bd. 12, Trop. Binnengew. Bd. 4, pp. 718—719.

Illustrations. FILARSZKY, *l. c.*, figs. 58—62.

Plants more or less stiff, elongate, not at all glossy. *Branchlets* long, c. 3 cm, consisting of 4 elongated articulations. *Internodes* shorter than the branchlets, whorls close together. *Bract-cells* 3, verticillate, anterior ones as long as the oogonia or somewhat shorter, posterior one very short. *Coronula* 143—152 μ high, individual cells free, divergent.

JAVA: Priangan, Telaga Balèkambang, in a ditch, 5 VIII 1930, VAN STEENIS 4524 (Bz); Banjoemas, Dijèng plateau, spring basin on the left border of the G. Serajoe, alt. 2000 m, 5 VI 1929, German Limnol. Sunda Exped. D6ba (Bu-Mus), *type*, two specimens without ripe oospores.

Remarks. FILARSZKY established this form on the extremely long coronula-cells but his type specimen has no ripe oogonia, and moreover, in contradistinction to FILARSZKY's note on p. 719, the cells are shorter than those of f. *javanica*. Another characteristic of this form is the elongated stature in contradistinction to the compact habit of f. *javanica*, and in agreement with this the branchlets are twice as long. Therefore I did not unite this form with the preceding one.

According to T. F. ALLEN's terminology (1882, p. 361) this form might be described as: forma *macrocarpa, meioptila* vel *microptila, verticillata, leiopyrena, condensata.*

Ecology. To the Sunda specimen can be added: temp. 16.1° C., pH 6.7, alkalinity 0.48.

Distribution. 7° S.; ASIA, Malaysia: Java.

6. Chara succincta A. BRAUN in Abh. Kön. Akad. Wiss. Berlin, 1882, pp. 114—115, pl. 7, figs. 200—202; T. F. ALLEN, Americ. Charac. 1, 1888, p. 54 (*nom. tant.*); NORDSTEDT in Lunds Univers. Års-skr. 25, 1889, p. 16 (*nom. tant.*); id. in Proc. Roy. Soc. Vict. 31, 1918, p. 5 (forma *novicaledonica* ined.); DIXIT in Journ. Ind. Bot. Soc. 10, 1931, p. 205, figs. 2—3.

Plant monoecious, entirely without cortex, flexible, transparent, bright-green, 10—15 cm high, not at all incrusted. *Stem* slender, c. 500 μ in diam. *Internodes* $^1/_3$—$^1/_2$ the length of the branchlets. *Stipulodes* in a single whorl, small, acute, as numerous as, and opposite the branchlets, sometimes rudimentary. *Branchlets* 7—8, composed of 5 articulations, of which the ultimate one is very short, acute, 2—4 cm long. *Bract-cells* 5—6 at the lower nodes, 3 at the ultimate one, anterior cells $^3/_4$ as long as the oogonium, posterior ones up to $^1/_4$ the length of the oogonium. *Bracteoles* similar to the posterior bract-cells. ♂ and ♀ *gametangia* not together at the base of the branchlet-whorls; clusters of oogonia only both inside and outside the base of the whorls. At the lowest branchlet-node mostly only the antheridia are found solitary or two together, however, sometimes one antheridium and one oogonium or two oogonia may be found together there. If the second branchlet-node is fertile, there are only antheridia extant. Antheridia c. 356 μ in diam. *Oogonia* c. 710 μ long (incl. coronula), c. 445 μ wide; *spiral-cells* showing 11—12 convolutions; *coronula* 100—108 μ high, c. 135 μ wide at base, individual cells compact, blunt; *oospores* dark chestnut-brown to almost black, c. 535 μ long, c. 312 μ wide, with 9—10 ridges.

NEW CALEDONIA: near Nouméa, VII 1896, BALANSA s.n. (P), *type* of *C. succincta* f. *novicaledonica* NORDST. ined.

Remarks. As BRAUN states in a letter to ASCHERSON (1878, p. 257), the species is different from *C. corallina* by the absence of antheridia at the base of the whorls; these are only extant at the lowest two branchlet-nodes. Other distinguishing characters are the smaller habit of the plant, and the smaller oogonia. *Chara pashanii* has no gametangia at the base of the whorls and no bract-cells at the ultimate branchlet-node.

The situation of the stipulodes is used in our key as a peculiarity of this species; in contradistinction to the hitherto mentioned ecorticate species they are opposite the branchlets and not alternating as NORDSTEDT already remarked (1882, p. 115), though he wrote on the same page "Stipulae alterniren mit den Blättern"! Probably the word "nicht" has been dropped.

DIXIT (1931, p. 207) noticed in his plant a number of stem-node bulbils in the month of January. BALANSA's plant collected in August does not show any trace of bulbils.

In one case I saw at the first branchlet-node an antheridium and an oogonium originating from the same cell, however, as is always the case in the genus

Lamprothamnium, the antheridium is situated above the oogonium. As too few ♂ and ♀ gametangia are preserved — and as, according to DIXIT, who had the opportunity to study fresh material, almost every part of this species even when found at the same place is variable — it requires more plants to ascertain if this is the normal position.

The various dimensions, and other characteristics of the above cited plants agree fairly well with the type description of BRAUN and as I have not seen the type itself, I have not cited the plant under the *nomen nudum* of NORDSTEDT, f. *novicaledonica*.

Ecology. All the year round in ponds with a high salinity. In the small island of Salsette, Bombay, it thrives in saline water having 2.5 % NaCl. It is mixed there with two *Spirogyra* species.

Distribution. Between 28° N. and 23° S.; NEW CALEDONIA. Moreover in lit.: ASIA, India: Isle of Salsette, DIXIT (1931, p. 205) — AFRICA: Libyan desert, BRAUN & NORDSTEDT (1882, p. 114); Mauritius, ex DIXIT (1931, p. 206).

7. Chara pashanii DIXIT in Journ. Ind. Bot. Soc. Bot. 14, 1935, p. 258.

Illustrations. DIXIT, *l.c.*, f. 1; the pres. paper, f. 11*a*.

Plant monoecious. *Stem* slender, c. 445 μ in diam. *Internodes* somewhat shorter than the branchlets. *Cortex* and *spine-cells* absent. *Stipulodes* opposite the branchlets, rudimentary. *Branchlets* 8—10 in a whorl, incurved, c. 2 cm long, S-shaped, composed of 3—5 articulations, the lower two frequently shorter than the following two, ultimate one c. 225 μ long, acute. *Bract-cells* 2—3, slender, usually reduced, lacking at the upper two nodes. *Bracteoles* 2, somewhat longer than the oogonia. ♂ and ♀ *gametangia* together at the two lowest nodes, not at the base of the whorls, usually two antheridia below 2—3 oogonia. *Antheridia* 198—225 μ in diam., earlier ripe than oogonia. *Oogonia* 620—700 μ long (incl. coronula), 460—480 μ wide; *spiral-cells* showing 8—10 convolutions; *coronula* 85—95 μ high, 170—180 μ wide at base; *oospores* black, 400—445 μ long, 267—289 μ wide with 6—7 ridges. *Bulbils* of the "strawberry type" at the lower stem-nodes, from which transparent rhizoids take rise.

INDIA: Malabaria, Pashan near Poona, in a ditch, XII 1930, DIXIT s.n. (L), duplicate of the *type*.

Remarks. DIXIT, in his article, emphasizes that *Chara pashanii* does not have any trace of even rudimentary stipulodes. The author was so kind as to send me some material, in which I could state, however, that rudimentary stipulodes were really present (cf. f. 11*a*). The plant has indeed so many characters of its own, that I share DIXIT's opinion in regarding it as new.

Chara pashanii is at once recognized by the wild tulip-shaped whorls of branchlets. It is nearly allied to *C. Braunii* but has no corona-like termination to the branchlets, whereas the stipulodes are always rudimentary and opposite the branchlets. The other resembling monoecious haplostephanous *Chara* species are *C. corallina*, which has the gametangia at the base of the whorls, *C. nuda*, which has solitary gametangia and *C. succincta*, which has oogonia at the base of the whorls, a fewer number of branchlets and well developed bract-cells, occurring at the ultimate node too.

Ecology. *C. pashanii* is much incrusted with lime. As an epiphyt is mentioned a species of *Zygnema*.

Distribution. 18° N.; ASIA, India: Malabaria.

8. Chara nuda PAL in Journ. Linn. Soc., Bot., 49, 1931, p. 81, pl. 15; id. in Journ. Burma. Res. Soc. 18, 3, 1929, p. 113 (*nom. tant.*).

Plant monoecious, entirely ecorticate, up to 15 cm high. *Stem* slender, 350 μ in diam. *Internodes* shorter than the branchlets. *Stipulodes* in a single whorl, usually rudimentary. *Branchlets* 7—8 in a whorl, composed of 5 articulations, without a corona-like termination. *Bract-cells* rudimentary. *Bracteoles* 0.5—1 times as long as the oogonium. ♂ and ♀ *gametangia* solitary at the two lowest branchlet-nodes, lacking at the base of the whorls. *Antheridium* 230 μ in diam. *Oogonia* 800 μ long, 525 μ wide; *spiral-cells* showing 14 convolutions; *coronula* 70 μ high, 190 μ wide at base, individual cells connivent; *oospores* black, 450 μ long, 330 μ wide, showing 12 inconspicuous ridges, ending in short basal claws.

Remarks. *Chara nuda* is closely allied to *C. Braunii* from which it can be distinguished by the rudimentary stipulodes, the solitary gametangia and the lack of a corona-like termination to the branchlets. From the other ecorticate monoecious *Haplostephanae* *C. corallina* and *C. fulgens* it is distinguished by having the gametangia at the branchlet-nodes only, whereas *C. pashanii* has aggregated gametangia. No specimens examined.

Ecology. The small plant is usually heavily incrusted with lime. It is collected in a swift flowing stream.

Distribution. 22° N.; ASIA: Burma.

II. Subsectio CORTICATAE A. BRAUN in HOOKER's Journ. Bot. 1, 1849, p. 200; id., id., p. 296; id. in Monatsber. Kön. Akad. Wiss. Berlin f. 1867, p. 799, 1868; BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 18; T. F. ALLEN, Charac. America 1, 1888, p. 54; NORDSTEDT in Proc. Roy. Soc. Vict. 31, N.S., 1918, p. 5; GROVES & ALLEN in Proc. Roy. Soc. Queensl. 46, 1935, p. 55; ZANEVELD in Blumea 3, 1939, p. 380.

Cortical-cells on stem present, on branchlets absent or imperfectly present.

Key to the series.

1a.	All branchlet-articulations ecorticate	1. GYMNOCLEMAE
b.	Lowest branchlet-articulation ecorticate	2. GYMNOPODES

1. Series GYMNOCLEMAE ZANEV., nov. nom. — *Gymnophyllae* A. BRAUN in HOOKER's Journ. Bot. 1, 1849, p. 201; id., id., p. 296.

All articulations of the branchlets destitute of cortical-cells.

Remarks. The same reasons which GROVES led to the alteration of the names *Homoeophyllae* and *Heterophyllae* into *Homoeoclemae* and *Heteroclemae* have influenced me to the alteration of BRAUN's name. This is in agreement with art. 62 of the International Rules of Botanical Nomenclature.

9. **Chara fibrosa** AG. ex BRUZELIUS, Observ. gen. Char., 1824; AGARDH, Syst. Alg., 1824, p. 129; BRUZELIUS & FÜRNROHR in Flora 9, 1826, p. 490; KUETZING, Spec. Alg., 1849, p. 521; WALLMAN in Act. Soc. Linn. Bordeaux 21, 1856, p. 53 — *Chara Benthamii*; *C. Curtissii*; *C. flaccida*; *C. flaccida* var. *brevibracteata*, var. *Gaudichaudii*, var. *oligarthra major*, var. *Wightii*; *C. gymnopitys*; *C. gymnopitys* var. *Benthamii*; *C. siboga*; cf. subspecies.

Plant monoecious, bright to brownish-green, flexible, 25—40 cm high. *Stem* moderately stout, 450—570 μ in diam. *Internodes* 1—4 times the length of the branchlets. *Stem-cortex* diplostichous, usually cells of the primary series more prominent than the secondary ones. *Spine-cells* single, acute, very variable in length, usually up to 165 μ long, however, a whorl of very long spine-cells (up to 1750 μ) pointing upwards is sometimes present just above each whorl of branchlets, whereas the upper spine-cells of a stem-internode are pointing downwards. *Stipulodes* forming a single whorl, well developed, elongated, acuminate, varying in number from as many as to twice as many as the number of branchlets, maximum length c. 2000 μ. *Branchlets* 8—16, consisting of 3—6 articulations, without cortex. *Bract-cells* 4—10, variable in length up to 4 times as long as the mature oogonia, acute at the apex. *Bracteoles* similar to the anterior bract-cells. ♂ and ♀ *gametangia* solitary or rarely geminate, together at the two or three lowest branchlet-nodes. *Antheridia* 300—450 μ in diam. *Oogonia* variable in length, up to 800 μ long, up to 555 μ wide; *spiral-cells* showing 8—11 convolutions; maximum height of *coronula* 100 μ, maximum breadth at base 180 μ; *oospores* golden-brown to black, 350—550 μ long, 275—400 μ wide, with 7 ridges.

Remarks. The present species was mentioned by BRAUN (1849, p. 297) as a synonym of *C. flaccida* var. *Gaudichaudii*. However, the name *C. fibrosa* has date priority.

Another interesting question is that of the delimitation of this highly variable species. As is pointed out below, I unite the three species *C. Benthamii* A. BR., *C. gymnopitys* A. BR. and *C. flaccida* A. BR. as subspecies into one large species for which the oldest name has to be accepted, i. e. *Chara fibrosa* AG. ex BRUZ. Most probably PAL's *Chara burmanica* belongs to this species in which case it has to be regarded as a subspecies too. As I have not seen a specimen I have to consider it provisionally as a separate species. It is distinguished by the entire absence of bract-cells and spine-cells, and the much longer oospores which are 700 μ long.

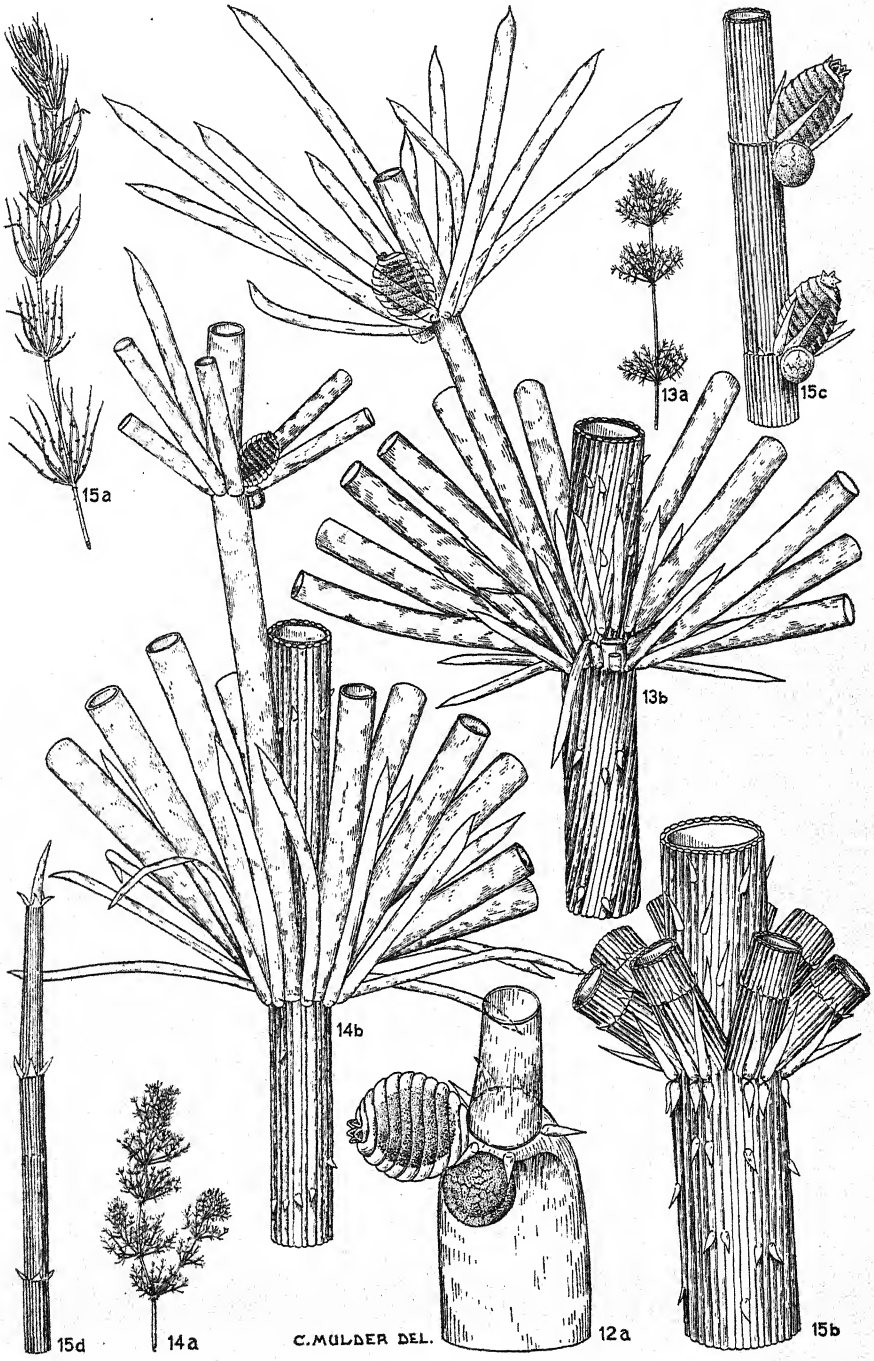
Another nearly allied species is *Chara erythrogyna* GRIFF. which differs by having the antheridia and oogonia produced at different branchlet-nodes. The same is the case with *C. psilopitys* A. BR., described from Australia and S. America (1882, p. 131). The only difference mentioned is the size of the stipulodes, which is very small.

The reasons why I unite the three species of BRAUN into a single one may be discussed now. *C. Benthamii* was established by BRAUN on account of the number of stipulodes being as numerous as the branchlets, whereas in *C. gymnopitys* and *C. flaccida* the number of stipulodes is twice as numerous as the branchlets. In studying the type of *Benthamii* from Hongkong it seems that this character is not constant, and the same is true for the number of stipulodes in the other species, as several authors already stated before. Therefore some authors followed BRAUN in describing specimens with 8—14 stipulodes as belonging to a separate species *C. Benthamii,* whereas others have described them as *C. gymnopitys* var. *Benthamii.*

JAMES GROVES, the late well-known authority on *Charophyta,* first followed BRAUN (1912, p. 70). Later on, when dealing with the Indian *Charophyta* (1924, p. 373), he treated *C. Benthamii* as a form or variety of *C. gymnopitys,* but again in his Madagascarian *Charophyta* (1927, p. 134) GROVES separated the two species. In his last paper written in collaboration with G. O. ALLEN (1937, p. 57), GROVES regarded once more the plants having one stipulode to each branchlet as a variety of *C. gymnopitys.*

With regard to the foregoing I examined very scrupulously the plants on this characteristic, and I found that a subdivision into two groups is possible. Into the ssp. *Benthamii* I insert the plants with 8—14 stipulodes, and those with more stipulodes and with a black oospore into ssp. *gymnopitys.* To this character of ssp. *Benthamii* but a few others are to be added. First of all the stipulodes are frequently longer and wider, and secondary the ripe oospores of ssp. *gymnopitys* are the largest, but the oogonia the smallest. In ssp. *gymnopitys* the number of striae is usually a little higher.

Fig. 12, *Chara corallina*; *a.* fertile branchlet-node, × c. 17 — Fig. 13, *Chara fibrosa,* plant intermediate between ssp. *Benthamii* and *gymnopitys*; *a.* habit, nat. size; *b.* stem-node with part of fertile branchlet, × c. 15 — Fig. 14, *Chara fibrosa* ssp. *gymnopitys* var. *typica*; *a.* habit, nat. size; *b.* stem-node with part of fertile branchlet, × c. 15 — Fig. 15, *Chara brachypus*; *a.* habit, nat. size; *b.* stem-node, × c. 18; *c.* fertile branchlet-nodes, × c. 20; *d.* apex of branchlet, × c. 20.


15a
13a
15c
13b
14b
15d
14a
C. MULDER DEL.
12a
15b

As to the main difference of ssp. *gymnopitys* and *flaccida*, I have to add that this is only to state with certainty on examining plants with ripe oospores. These are in the typical *flaccida* plants golden-brown and in *gymnopitys* black. But this character is also variable as I observed in the exsiccatae and as was already stated e. g. by GROVES in a plant from Ceylon (1921, p. 102) being "very dark brown". Other characters of minor importance are the oogonia being larger and more elongated, whereas they have a more roundish form in ssp. *gymnopitys*.

Finally there are also transitions between ssp. *Benthamii* and *flaccida* which is clearly shown in a plant from Tonkin in the Kew herbarium collected by BALANSA (No 16), to which J. GROVES adds on a label: "I should refer this to *C. flaccida* BRAUN on account of the golden-brown colour of the oospores, but it is distinctly unistipulate".

According to the above I consider the types of *Benthamii*, *gymnopitys*, and *flaccida* as the extremes of but one and the same widely distributed species *Chara fibrosa*, and I give them the rank of subspecies.

Ecology. Cf. the subspecies.

Distribution. Between 50° N. and 50° S.; *C. fibrosa* is widely distributed in the tropical and subtropical regions of Asia, Africa and Australia, whereas the occurrence in America is not certain; cf. the subspecies.

subsp. A. **Benthamii**[1]) (A. BRAUN) ZANEV., nov. comb. — *C. Benthami* A. BRAUN in Monatsber. Kön. Akad. Wiss. Berl. f. 1867, p. 799, 1868 (*nom. tant.*), (non NORDSTEDT in Acta Univ. Lund. 16, 1880, p. 20); BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berl., 1882, pp. 18, 117; H. & J. GROVES in Philipp. Journ. Sci. 7, 1912, p. 70 — *Chara Benthamii* A. BR. ap. J. GROVES in Journ. Linn. Soc., Bot., 48, 1928, p. 134; AGHARKAR & KUNDU in Journ. Dep. Sci., N. S. 1, 1937, p. 14; ZANEVELD in Blumea 3, 2, 1939, pp. 380—381 — *Chara gymnopitys* A. BR. var. *Benthamii* (A. BR.) J. GROVES in Journ. Linn. Soc., Bot., 46, 1924, p. 373; GROVES & ALLEN in Proc. Roy. Soc. Queensl. 46, 1935, p. 57.

Illustrations. BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, pl. 7, f. 213; AGHARKAR & KUNDU, Journ. Dep. Sci. 1, 1937, pl. 7, f. 1—5; the pres. paper, figs. 19*a*—*b*.

---

[1]) The orthography of the name "*Benthamii*" instead of "*Benthami*" is based upon the International Rules of Nomenclature, cf. also GROVES (1927, p. 134).

Plant monoecious, bright to greyish green, not incrusted at all, up to 40 cm high. *Stem* moderately stout, c. 570 μ in diam. *Internodes* 2—3 times the length of the branchlets. *Cortex* diplostichous, usually both series equally prominent though in many cases the primary series are more prominent. *Spine-cells* solitary, acute, up to 120 μ long, 45 μ wide. *Stipulodes* forming a single whorl, as numerous as the branchlets or 1—3 more, $^1/_2$—$^1/_3$ as long as the lowest branchlet-articulation, the largest stipulode being 1600 μ long, 150 μ wide, acute. *Branchlets* 8—12, consisting of 3—6 articulations, diminishing in length towards the apex, ecorticate. *Bract-cells* 6(—8) at fertile nodes, 4(—6) at sterile nodes, at the terminal articulation of the branchlets only 2(—4), twice to thrice as long as the oogonium, apiculate, the posterior ones less developed. *Bracteoles* similar to the bract-cells, however, frequently a little shorter. ♂ and ♀ *gametangia* solitary or rarely geminate at the two lowest nodes. *Antheridia* 350—415 μ in diam. *Oogonia* 700—800 μ long (incl. coronula), 460—550 μ wide; *spiral-cells* showing 8—11 convolutions; *coronula* 70—100 μ high, 140—180 μ wide at base, individual cells converging; *oospores* black, 420—540 μ long, 275—400 μ wide with 7—9 well defined ridges.

CHINA: Hong Kong, Little Hong Kong, in ditches, II 1858, WILFORD 238, herb. HOOKER in (B), together with *N. flagelliformis*.

MALAY PENINSULA: Pahang, Raub, gold mine, 13 IV 1924, BURKILL, St. of Pahang. 17474 (Si); ibid., Simpan River, XI 1924, BURKILL, St. of Pahang s.n. (Si); Singapore, Singapore, lake in Botanic Gardens 1896, RIDLEY, Fl. of Singap. 6915 (Si); ibid., no date, RIDLEY s.n. (Si); ibid., 8 VII 1896, BLOW, Charophyta Blowiana 50 (K); ibid., 23 III 1908, no collector's name (K); ibid., VIII 1922, HOLTTUM, Fl. of Singap. 8389, (Si); ibid., 4 X 1929, NUR s.n. (Bz), sterile specimen; ibid., VII 1937, PESTAVA s.n. (L); ibid., Reservoir, 1906, RIDLEY, Fl. of Singap. 12567 (Si), immature, therefore not to be identified with certainty; ibid., Clumy Lake, XII 1922, HOLTTUM, Fl. of Singap. 10015 (Si).

JAVA: Semarang, marsh near Sf. Gernoe, Pegandan S. C. S., XII 1935, HEMLE s.n. (Bz), slender specimen without ripe oogonia.

PHILIPPINE ISLANDS: Luzon, Prov. of Ilocos Norte, Burgos, 2 III 1917, RAMOS, Fl. of Philipp. 27248 (K, L), mixed with *Chara corallina*[1]).

KAI ISLANDS: Ohoitiel, near Toeal, 2 V 1922, JENSEN 306 (Bz, L).

NEW CALEDONIA: without exact locality and date, BALANSA 1553 (P).

Remarks. The subspecies *Benthamii* is very nearly allied to ssp. *gymnopitys*, but differs by having one stipulode at the base of

---

[1]) This specimen has a note by J. GROVES: "This seems to me to be referable to *C. Benthamii* BRAUN, though in some of the whorls the stipulodes are more numerous than the branchlets".

each branchlet. From ssp. *flaccida* it can be distinguished by the black ripe oospore.

BLOW's specimen no 50 has very long spine-cells, viz. as long as the diam. of the stem. Sometimes I saw two stipulodes between two branchlets of which only one was developed and the other rudimentary. In the Java specimen collected by HEME some oogonia have coronula cells which are globular in the lower parts.

Ecology. In stagnant fresh water of lakes and ditches, and in marshes. The ssp. probably grows only in flat country. Most plants from the lake in the Singapore Botanic Gardens have a remarkable bright-green colour and very long internodes probably due to a high intensity of light.

The ssp. is only once found growing mixed up with *Chara corallina*. The seasonal distribution is from March to June and from October to January.

Distribution. Between 22° N. and 22° S.; ASIA, China; Malaysia: Malay Peninsula, Java, Philippine Islands, Kai Islands — AUSTRALIA, New Caledonia. Moreover in lit.: ASIA: India, AGHARKAR & KUNDU (1937, p. 14) — AFRICA: Madagascar, GROVES (1927, p. 134), ZANEVELD (1939, p. 381) — AUSTRALIA: Queensland, GROVES & ALLEN (1935, p. 57).

subsp. B. **gymnopitys** (A. BRAUN) ZANEV., nov. comb. — *Chara gymnopitys* A. BRAUN in Linnaea 25, 1852, p. 708; id. in HOOKER's Flora Tasmanica 2, 1860, p. 159; id. in ZELLER in Journ. Asiat. Soc. Bengal 42, 1873, p. 193; BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, pp. 18, 124; T. F. ALLEN, Charac. Americ. 1, 1888, p. 54 (*nom. tant.*); NORDSTEDT in Hedwigia 27, 1888, p. 190; id. in Lunds Univers. Årsskr. 25, 1889, p. 33; GUTWINSKI & NORDSTEDT in Bull. Int. Ac. Sci. Cracovie, Cl. Sc. Math. Nat. 1902, p. 578; NORDSTEDT in Proc. Roy. Soc. Victoria 31, 1918, p. 5 (*nom. tant.*); RIDLEY in Journ. Straits Branch R. A. Soc. 80, 1919, p. 164; J. GROVES in Journ. Linn. Soc., Bot., 46, 1922, p. 70; id. in Journ. Linn. Soc., Bot., 46, 1924, pp. 363, 373; G. O. ALLEN in Journ. Bombay Nat. Hist. Soc. 30, 1925, p. 599; J. GROVES in Journ. Linn. Soc., Bot., 48, 1927, p. 134; PAL in Journ. Burma Res. Soc. 18, 3, 1929, p. 113 (*nom. tant.*); id. in Journ. Linn. Soc., Bot., 49, 1932, pp. 65, 84; DIXIT in Journ. Ind. Bot. Soc. 14, 1935, p. 261; GROVES & ALLEN in Proc. Roy. Soc. Queensl. 46, 1937, p. 56; AGHARKAR & KUNDU in Journ. Dep. Sci., N. S. 1, 1937, p. 14; ZANEVELD in Blumea 3, 1939, pp. 380, 381.

Illustrations. KUETZING, Tab. Phyc. 7, 1857, pl. 50, f. 1;

BAILEY, Compreh. Catal. Queensl. Pl., 1909, pl. 690; AGHARKAR & KUNDU in Journ. Dep. Sci., N. S. 1, 1937, pl. 7, figs. 6—9, pl. 8, f. 1.

Plant monoecious, brownish-green, covered with clay, up to 30 cm high. *Stem* rather stout, 450—520 μ in diam. *Internodes* 1—4 times the length of the branchlets. *Cortex* diplostichous, usually cells of the primary series more prominent than the secondary ones. *Spine-cells* single, acute, c. 165 μ long, c. 65 μ wide at base. *Stipulodes* forming a single whorl, as numerous as to twice as numerous as the branchlets, acute, c. 600 μ long, c. 75 μ wide, however, the maximum length is much greater, as AGHARKAR & KUNDU (1937, p. 15) measured a length of 2500 μ, and GROVES (1928, p. 135) of 3100 μ. *Branchlets* 9—16, consisting of 4—5(—6) articulations, ecorticate, strongly acuminate at the apex. *Bract-cells* 6—10, very long (in some plants of Madagascar they were 1200—1300 μ long, according to GROVES [1928, p. 135]), apex acute, posterior bract-cells on fertile nodes two times, anterior ones 3—4 times the length of the ripe oogonium, c. 150 μ wide. *Bracteoles* similar to the posterior bract-cells, 2—3 times as long as the oogonia, 150 μ wide. ♂ and ♀ *gametangia* produced at the three lowest nodes, solitary at the same nodes. *Antheridia* 300—400 μ in diam. *Oogonia* 510—720 μ long (incl. coronula), 385—500 μ wide; *spiral-cells* showing 9—11 convolutions; *coronula* c. 70 μ high, c. 160 μ wide at base, individual cells ovate, contiguous; *oospores* dark purple-brown to black, 330—650 μ long, 280—490 μ wide, with 9—11 ridges.

Remarks. The subspecies *gymnopitys* is the most variable of the three. It is subdivided by BRAUN (1882, pp. 18, 124—128) into four varieties of which the three last ones got a name, but the var. α was quoted without a name. It is doubtless that BRAUN hereby has meant the var. *typica*. This subdivision is mainly based on the length of the ripe oospores, though in this respect the sizes given on p. 18 of his paper are different from those cited in his descriptions on the pp. 124—128. All the plants studied by me belong to the typical variety, of which the ripe oospores have a length of 330—425 μ. A subdivision of the varieties seems not desirable just now.

BRAUN, in the type description (1852, p. 708), mentions the occurrence of a whorl of very long spine-cells just above the whorl of branchlets. This whorl was very well represented in a specimen from Borneo, MOTLEY 325, which I figured separately (cf. fig. 13*a*—*b*) as it is intermediate between ssp. *Benthamii* and *gymnopitys*.

As it is possible that one of the other varieties, hitherto only

recorded from Australia, may be found in our region, I give their principal characters in the following table.

TABLE XIV.

Characters / varieties of ssp. *gymnopitys*	Length of ripe oospore in μ	Number of ridges	Development of prim. and sec. cortical cell-series	Shape of spine-cells
typica (A. Br.) Zanev.	330—550	10—11	equal	short, acute
duriuscula (A. Br.) Zanev.	440—470	10	prim. more	papilli-form
acanthopitys (A. Br.) Zanev.	700—720	9	id.	very long
trachypitys (A. Br.) Zanev.	680—720	11—12	id.	papilli-form

T. F. Allen still distinguishes in Bull. Torrey Bot. Club 20 (1893, p. 20) another variety collected in U.S.A., viz. *keukensis*, which Robinson (1906, p. 273), and with good reason in my opinion, has regarded as a species, because the series of cortex-cells are thrice the number of the branchlets. Therefore the ssp. is not yet recorded from America.

The principal characters distinguishing this ssp. from the other two are the number of stipulodes agreeing with the number of branchlets and the black oospore.

Ecology. The ssp. *gymnopitys* is a prominent element in the rice-fields or paddies of the tropics and subtropics, sometimes forming a vegetable carpet, which according to Pal (1932, p. 51) may be aptly described as "forests" of *Chara* and *Nitella*. It sometimes occurs in running and sometimes in stagnant water of c. 35 cm depth, and never deeper which probably shows that this ssp. needs a high intensity of light. In this respect Pal's statement is of importance (1932, p. 54), which runs: "Plants of *N. acuminata, N. oligospira* and *C. gymnopitys* grown in glass-jars and placed at well-lighted window still suffered from lack of sufficient illumination, which was manifested by thin and lanky growth".

As is evident from the record in BRAUN & NORDSTEDT (1882, p. 126), the water may be a little brackish.

Though Malaysian plants have never been found in February and March, the species is probably present all the year round.

Distribution[1]). Between 40° N. and 50° S.; ASIA, Japan; India: Pegu; Indo-China; Malaysia: Malay Peninsula, Sumatra, Java, Borneo, Celebes, Timor, Philippine Islands, New Guinea — AUSTRALIA, Tasmania, cf. var. *typica*. Moreover in lit.: ASIA, China, GROVES (1924, p. 373); India: India Deserta, GROVES (1924, p. 373); Malabaria, DIXIT (1935, p. 61); Gangetic Plain, ALLEN (1925, p. 597); Bengal, AGHARKAR & KUNDU (1937, p. 15); Burma, PAL (1932, p. 34); New Guinea: Papua, NORDSTEDT (1889, p. 34); ? Marianne Islands, NORDSTEDT (1889, p. 8)[2]) — AFRICA, Madagascar, GROVES (1928, p. 134); ZANEVELD (1939, pp. 380, 382) — AUSTRALIA: Victoria, BRAUN & NORDSTEDT (1882, p. 126); Tasmania, New Zealand, BRAUN (1852, p. 708), BRAUN & NORDSTEDT (1882, pp. 124—128), NORDSTEDT (1888, p. 191).

var. α **typica** (A. BRAUN) ZANEV., nov. comb. — *Chara gymnopitys* A. BRAUN in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 124, *pro parte*; NORDSTEDT in Hedwigia 27, 1888, p. 190; id. in Lunds Univers. Årsskr. 25, 1889, p. 33 (f. *aequistriata*); id. in Forschungsreise S. M. S. "Gazelle" 4, 1889, p. 8 (f. *longibracteata*); DE WILDEMAN, Prodr. Flor. Alg. Ind. Néerl., 1897, p. 30; id., Suppl. et Tabl. Stat., 1899, p. 96; H. & J. GROVES in Philipp. Journ. Sci. 7, 1912, p. 70 — *Chara gymnopitys* A. BR. var. *"alpha"* A. BR., T. F. ALLEN, Charac. Americ. 1, 1888, p. 54 (*nom. tant.*); id. in Bull. Torrey Bot. Cl. 22, 1895, p. 70; id. in Charac. Japon. Exsicc. No 10.

Illustrations. The pres. paper, figs. 14*a*—*b*.

Primary and secondary *cortical cell-series* equally developed. *Spine-cells* short, acute. *Oogonia* 510—620 μ long (incl. coronula), 385—475 μ wide; *spiral-cells* showing 11—12 convolutions; *oospores* 330—550 μ long, 280—390 μ wide, with 10—11 ridges.

INDIA: Pegu, Arracan, Kolodyne valley, in rice-fields, X 1869, KURZ 1964 (B), a slender specimen with short stipulodes, c. 175 μ long, c. 60 μ wide.

INDO-CHINA: Tonkin, near Quang-yen, in the river, 5 IX 1885, BALANSA 18 (K, B), a specimen with very short stipulodes.

---

[1]) Cf. note [1]) on p. 59.

[2]) In the remaining literature this locality is only mentioned for ssp. *flaccida*, therefore not certain for ssp. *gymnopitys*.

MALAY PENINSULA: Perak, Menglember near Ipoh, in streams and hollows holding water, among the old mine heaps between Menglember and Lakat, 12 XI 1917, BURKILL, St. of Perak 2794 (K, Si); Pahang, Telok Sisik, Kuantan, in a pool of brown peaty water, 4 XII 1924, BURKILL, St. of Pahang 17347a (Si); Negri Sembilan, Gemas, in pools, 9 VIII 1919, CHIPP, Fl. of Negri Sembilan 4981 (K, L, Si), three immature specimens, therefore determination not certain; Malacca, in a rice-field along the road to Batu Truja, VII 1889, RIDLEY s.n. (Si); Singapore, Bot. Gard. Lake, 1 XII 1896, RIDLEY, Fl. of Singapore 8089 (K, L), a plant with globose oogonia.

SUMATRA: Tapanoeli, Lake Toba, 9 I 1923, HEIDE s.n. (S.).

JAVA: Buitenzorg, Dèpok, 90 m alt., 25 VI 1922, BAKHUIZEN VAN DEN BRINK 5578 (Bz, L); ibid., Buitenzorg, V 1922, HEIDE s.n. (Bz, L), the plant has a remarkably transparent stem.

BORNEO: Sarawak, Kapit, Upper Rejang River, in a shallow pond, 1929, CLEMENS 21499 (B, Bz); ibid., without exact locality and date[1]), MOTLEY 329 (K).

PHILIPPINE ISLANDS: Sibuyan, Magellanes, Mt. Giting-Giting, Prov. of Capiz, IV 1910, ELMER, Bur. of Sci. 12382 (Bz, K, L).

NEW GUINEA: N. N. G., Alkmaar, New Guinea Exped., 23 VII 1907, LORENTZ 15 (L).

TASMANIA: without exact locality and date, F. VON MUELLER 24 (L).

Remarks. Variety *typica* is the most widely distributed one, the other three, cf. p. 160, being only recorded from Australia.

NORDSTEDT (1889, p. 8) writes, that ssp. *gymnopitys* is distributed "im östlichen Afrika, im Ostindien, Borneo, auf den Mariannen und Celebes". However, this is in accordance with the distribution of ssp. *flaccida* cited in the "Fragmente" (1882, p. 129), up to that time the only source from which the distribution of these subspecies could be drawn (cf. General Part, Chapt. I, § 2). I think it therefore most probable that NORDSTEDT has erroneously mentioned the distribution of ssp. *flaccida* under ssp. *gymnopitys*.

Distribution. Between 40° N. and 45° S.; ASIA, India: Pegu; Indo-China; Malaysia — AUSTRALIA, Tasmania. Moreover in lit.: ASIA, Japan, T. F. ALLEN (1895, p. 71); ?Marianne Islands, Celebes, Timor, NORDSTEDT (1889, p. 8) — AFRICA, N. Afr.: Socotra; S. Afr.: Cape Colony, GROVES (1924, p. 373) — AUSTRALIA: W. Australia, Carpentaria, Arnhem Land, Queensland, Victoria, NORDSTEDT (1888, pp. 190—191; 1889, pp. 33—35), BRAUN & NORDSTEDT (1882, p. 125); Tasmania, BRAUN (1852, p. 708; 1882, p. 124).

subsp. C. **flaccida** (A. BRAUN) ZANEV., nov. comb. — *Chara flaccida* A. BRAUN in HOOKER's Journ. Bot. 1, 1849, p. 296; WALLMAN in

[1]) MOTLEY collected there between 1854 and 1859.

Act. Soc. Linn. Bordeaux 21, 1856, p. 52; T. F. ALLEN, Charac. Americ. 1, 1888, p. 55 (*nom. tant.*); GUTWINSKI & NORDSTEDT in Bull. Int. Ac. Sci. Cracovie, Cl. Math. Nat., 1902, p. 578; HATE in Journ. Bombay Nat. Hist. Soc. 19, 1909, p. 763; H. & J. GROVES in Philipp. Journ. Sci. 7, 1912, p. 70; J. GROVES in Philipp. Journ. Sci. 19, 1921, p. 664; id. in Journ. Linn. Soc., Bot., 46, 1921, p. 102; id. in Journ. Linn. Soc., Bot., 46, 1924, pp. 363, 372; PAL in Journ. Burma Res. Soc. 18, 1929, p. 113; id. in Journ. Linn. Soc., Bot., 49, 1932, p. 84; MIGULA in Hedwigia 70, 1931, p. 215; MUKERJI in Proc. 21st Ind. Sci. Congr., Bombay, 1934, p. 295; DIXIT in Journ. Ind. Bot. Soc. 10, 1931, p. 205; id. in Journ. Ind. Bot. Soc. 14, 1935, p. 261; AGHARKAR & KUNDU in Journ. Dep. Sci., N. S. 1, 1937, p. 15 — *Chara hydropitys* A. BR. var. *flaccida* A. BRAUN in HOOKER's Journ. Bot. 1, 1849, p. 297 — *Chara flaccida* A. BR. var. *Wightii* A. BRAUN in HOOKER's Journ. Bot. 1, 1849, p. 296; BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 128 — *Chara flaccida* A. BR. var. *Gaudichaudii* A. BRAUN in HOOKER's Journ. Bot. 1, 1849, p. 297; BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 128 — *Chara flaccida* A. BR. var. *brevibracteata* A. BRAUN in BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 129 — *Chara flaccida* A. BR. var. ? *oligarthra major* A. BRAUN in BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 129 — *Chara Curtissii* T. F. ALLEN in Robinson in Bull. New York Bot. Gard. 4, 1906, p. 272; T. F. ALLEN in Bull. Torrey Bot. Cl. 7, 1880, p. 107 — *Chara siboga* AGARDH in herb. SURINGAR (L).

Illustrations. T. F. ALLEN, Charac. Americ. 1, 1888, f. 50; AGHARKAR & KUNDU in Journ. Dep. Sci., N. S. 1, 1937, pl. 8, f. 1; the pres. paper, figs. 17*a*—*c*.

Plant monoecious, brownish-green, heavily incrusted, up to 35 cm high. *Stem* moderately stout, c. 500 μ in diam. *Internodes* 1—3 times the length of the branchlets. *Cortex* diplostichous, cells of the primary series more prominent than the secondary ones. *Spine-cells* single, acute, projecting horizontally, c. 65 μ long, c. 45 μ wide at base, however, sometimes rudimentary. *Stipulodes* forming a single whorl, up to twice as numerous as the branchlets, elongate, acute, usually 420—670 μ long (sometimes much longer), 40—65 μ wide, projecting more or less horizontally. *Branchlets* 10—12, consisting of 4—6 articulations, ecorticate, slender. *Bract-cells* 4—5 at the lowest nodes, 3 at the apex, straight or slightly incurved; anterior pair 1—2 times the length of the ripe oogonium, posterior pair on the first and second node similar to the anterior pair, on the other nodes, however, half as long as the oogonium;

the 3 apical bract-cells are different in length. *Bracteoles* similar to the anterior bract-cells, c. 120 μ wide. ♂ and ♀ *gametangia* usually at the lowest three nodes, now and then lacking at the third, solitary or geminate at the same nodes. *Antheridia* 300—350 μ in diam. (AGHARKAR & KUNDU cite [1937, p. 16] 408—464 μ). *Oogonia* up to 725 μ long (incl. coronula), 470—555 μ wide; *spiral-cells* showing 9—12 convolutions; *coronula* c. 75 μ high, c. 180 μ wide at base, apices of the individual cells contiguous; *oospores* golden-brown, 420—550 μ long, 310—395 μ wide, with 8—11 ridges.

INDIA: Malabaria, Madras, no date, WIGHT 133, herb. HOOKER in (B), *type* of *C. flaccida* var. *Wightii*; Gangetic Plain, Saharanpore, 1845, LEHMANN s.n., herb. BOISSIER in (B); Bengal, without exact locality and date, KURZ 2753 (B), *type* of *C. flaccida* var. *brevibracteata*, mixed up with *Nitella oligospira* and *Chara brachypus*; ibid., 1871, KURZ 2754 (B); ibid., c. 1872, KURZ 2755 (B).

INDO-CHINA: Tonkin, Onombi, in pools with brackish water, 5 XI 1885, BALANSA 16 (K, L); ibid., Kiên Khê, in the river Dông Hâm, 19 XI 1883, BON 2306 (P), mixed with *Chara brachypus*.

MALAY PENINSULA: Kedah, Lake Dayong Bonting, IX 1890, CURTIS, Fl. of Kedah 2587 (Si), three specimens; Malacca, Ayer Kerdi, 1899 ?, RIDLEY s.n. (Si), badly preserved specimen.

SUMATRA: Tapanoeli, Lake Toba, Batak districts, 16 VII 1904, VAN DAALEN 539b (Bz, L), mixed up with *Chara australis* and *C. zeylanica*.

JAVA: Banjoemas, Noesa Kambangan, in a ditch on the way to Permisan, II 1931, BOEDIJN 987 (Bz), very fine annular incrusted and overgrown with green algae; Soerabaja, Soerabaja, desa Glagah, III 1935, Bodemk. Ambtenaar s.n. (Bz), badly preserved specimen; ibid., Bawéan, 7 V 1928, KARTA 52 (Bz, L), heavily incrusted and very fragile with a note: "ager-ager".

BORNEO: S. and E. Division, Labuan-plateau, in ditches, with fresh water, no date, MOTLEY 9, herb. HOOKER in (K); two sterile specimens, therefore determination uncertain[1]); ibid., without exact locality and date, MOTLEY 218, herb. HOOKER in (K).

CELEBES: without exact locality, in ditches between plantations of *Colocasia*, no date[2]), ZOLLINGER 3440 (K, L).

PHILIPPINE ISLANDS: Mindanao, Subprov. of Bukidnon, in the vicinity of Tancular, VII 1916, FÉNIX, Fl. of the Philipp. 26079 (K, L).

SOEMBA: without exact locality and date, TEIJSMANN 11179 (Bz).

Vernacular names: Ganggeng (Malay); Rong ("= Fucus"), a name probably used in Tonkin for all larger algae.

Use: According to a note on the Bawean specimen it is used as agar-agar, but this is probably a mistake, as agar-agar is yielded by *Rhodophyta*.

[1]) This is the specimen cited in BRAUN & NORDSTEDT (1882, p. 129) as collected by "Mr BROTLEY".

[2]) ZOLLINGER collected there between 1842 and 1848.

R e m a r k s. The only constant character of ssp. *flaccida* in which it differs from ssp. *gymnopitys*, is the golden-brown colour of its ripe oospores. Other differences are to be found in the size of the oogonia which are larger in the case of *flaccida*, the oospores being more elongate, and the stipulodes larger and narrower.

When BRAUN described his new species *flaccida* (1849, p. 296) he subdivided it at once into two varieties, i. e. *Wightii* and *Gaudichaudii*. Moreover, he distinguished in the "Fragmente" (1882, p. 128) two other varieties, i. e. *brevibracteata* and "*? oligarthra major*". His subdivision is based on the situation of the gametangia: geminate or solitary, on the number of ridges and branchlet-articulations and on the length of the bract-cells.

However, as I was able to study BRAUN's specimens and a good number of other ones, I found so many plants with transitional characters that a subdivision is not possible. Surveying all the material I found it very uniform and at present no subdivision is needed.

Most probably the American *Chara Curtissii* T. F. ALLEN in ROBINSON (1906, p. 272) is a synonym of ssp. *flaccida*, but as I did not see a specimen, I cannot decide this with certainty. If this would be true, however, then the ssp. is also distributed in America. ROBINSON states that T. F. ALLEN's figure 50 (1888) represents *C. Curtissii*, but the terminal articulation is ecorticate in contradistinction to ROBINSON's description, where this author writes that the terminal cell is corticated.

E c o l o g y. Ssp. *flaccida* inhabits shallow fresh water pools, ditches, ponds, rice-fields, etc. In the lake Dayong Bonting (Malay Peninsula) the bottom must be a perfect cushion of this plant, as C. CURTIS writes on the label: "By the use of a stone and piece of cord masses were brought up at every throw."

The ssp. is also recorded from low level muddy areas of Salsette (DIXIT, 1931, p. 305) which are situated near the sea shore. BALANSA records on the label of the Tonkin plant No 16 that it occurs in brackish water. These notes indicate that the ssp. is able to withstand a low salinity.

The periods in which it is found indicate that it is present during the whole year.

Inhabitants of the same locality are *Nitella oligospira*, *Chara australis*, *C. brachypus* and *C. zeylanica*.

D i s t r i b u t i o n. Between 40° N. and 10° S.; ASIA, I n d i a:

Malabaria, Gangetic Plain, Bengal; Indo-China; Malaysia: Malay Peninsula; Sumatra; Java; Borneo; Celebes; Soemba; Philippine Islands. Moreover in lit.: Japan, MIGULA (1931, p. 215); India: W. Himalaya, MUKERJI (1934, p. 295); Malabaria, DIXIT (1931, p. 205; 1935, p. 261), Ceylon, GROVES (1921, p. 102), Coromandelia, GROVES (1924, p. 372), Burma, PAL (1932, p. 84); Marianne Islands, BRAUN (1849, p. 297) — ? AMERICA, Florida, T. F. ALLEN (1880, p. 107), ROBINSON (1906, p. 272), cf. remarks — AFRICA, Libyan Desert, BRAUN & NORDSTEDT (1882, p. 129).

10. Chara erythrogyna GRIFFITH, Not. Plant. Asiat. 2, 1849, p. 278; T. F. ALLEN, Charac. Americ. 1, 1888, p. 55 (*nom. tant.*); G. O. ALLEN in Journ. Ind., Bot., Soc. 7, 1928, p. 61; J. GROVES in Journ. Linn. Soc., Bot., 46, 1924, p. 372 — *Chara Griffithii* A. BRAUN in BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 130; PAL in Journ. Burma Res. Soc. 18, 1929, p. 113 (*nom. tant.*); id. in Journ. Linn. Soc., Bot., 49, 1932, p. 65—82; AGHARKAR & KUNDU in Journ. Dep. Sci., N. S. 1, 1937, p. 16 — *Chara erythrogona* GRIFFITH in J. GROVES in Journ. Linn. Soc., Bot., 46, 1924, p. 363; GROVES & ALLEN in Journ. Bot. 65, 1927, p. 339 — ? *Chara Thwaitesii* A. BRAUN in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 132.

Illustration. G. O. ALLEN, Journ. Ind. Bot. Soc. 7, 1928, pl. 6.

Plant monoecious, greyish green-brown, without incrustation, c. 25 cm high. *Stem* rather stout, 500—650 μ in diam., transparent. *Internodes* 1—3 times the length of the branchlets. *Cortex* diplostichous, cells of the primary series more prominent than those of the secondary ones. *Spine-cells* up to 1000 μ long (usually 600 μ), up to 36 μ wide at base, cone-like. *Stipulodes* in a single whorl, usually twice as numerous as the branchlets, elongate, with apiculate apices, c. 1600 μ long, c. 95 μ wide. *Branchlets* 13—16 in a whorl, c. 1.5—2 cm long, consisting of 6—8 articulations, ecorticate. *Bract-cells* 7—10, at the lower nodes usually 7—8, at the upper nodes 9—10, elongate, acute, up to 1000 μ long, 650 μ wide, anterior and posterior ones similar. *Bracteoles* twice the length of the oogonia. ♂ and ♀ *gametangia* disjuncted, produced at the 4—5 lowest branchlet-nodes, solitary or geminate. *Antheridia* usually at the two lowest nodes only, 250—360 μ in diam. *Oogonia* at the third and fourth branchlet-nodes only, c. 560 μ long (excl. coronula), c. 350 μ wide; *spiral-cells* showing 9—10 convolutions; *coronula* 40—45 μ high, c. 105 μ wide at base; *oospores* black, c. 400 μ long, c. 245 μ wide, with 8—9 ridges.

INDIA: "India orientalis", without exact locality and date, GRIFFITH s.n., herb. HOOKER in (B), *type* of *Chara Griffithii* A. BR.

Remarks. *Chara erythrogyna* is remarkable for the situation of the gametangia, being produced at different nodes of the branchlets, though the antheridia and oogonia are very seldom found together in the middle nodes. By this fact alone the species is distinguishable from the other haplostephanous diplostichous *Chara*'s with ecorticate branchlets, i. e. *C. fibrosa, C. burmanica,* and *C. psilopitys.*

As is already stated by several authors (G. O. ALLEN, 1928, p. 62; GROVES & ALLEN, 1927, p. 339) the present species is hardly separable from *C. Thwaitesii* A. BR. (1882, p. 132), which has the gametangia likewise disjuncted. The characteristics of the last-named species are the short stipulodes, and 10—12 branchlets composed of 4—5 articulations. However, these characters are extremely variable even in the same plant and it is therefore most probably to be regarded as a synonym of *C. erythrogyna,* though this can only be stated with certainty by experiments. As I did not see the type of *C. Thwaitesii,* I have not cited it as a synonym.

BRAUN states (1882, p. 130) that the specimen cited in our exsiccatae is identic with GRIFFITH's plant from Serampore, which was collected by HALOODAR and described as *C. erythrogyna.* However, BRAUN renamed the species as in his opinion the red colour of the oogonia is not a constant character, but changing during its lifetime and therefore not characteristic. This is in contradistinction to the now adopted International Rules. Moreover, the name was cited by him as "*erythrogona*".

J. GROVES (1924, p. 372) writes that *C. erythrogyna* occurs in Java and in Cochin-China. I could not find the original literature mentioning these localities, nor the exsiccatae. Therefore they are dubious.

Ecology. In a living state the antheridia are bright-red and the immature oogonia deep reddish brown, giving the plant a "very pleasant effect". It is found growing in roadside drains and in lakes, sometimes together with *Chara fibrosa* ssp. *gymnopitys.*

Plants with ripe oospores have been found in Burma from August to February.

Distribution: Between 30° N. and 8° S.; ASIA, India. Moreover in lit.: India: Gangetic Plain, BRAUN & NORDSTEDT (1882, p. 130), GROVES (1924, p. 372), GROVES & ALLEN (1927, p. 339); Bengal, GRIFFITH (1849, p. 279); Burma, PAL (1932, p. 82); ? Indo-China: Cochin-China, GROVES (1924, p. 372); ? Malaysia: Java, ex GROVES (1924, p. 372).

11. Chara burmanica PAL in Journ. Linn. Soc., Bot., 49, 1932, p. 83, pl. 16; id. in Journ. Burma Res. Soc. 18, p. 113 (*nom. tant.*).

Plant monoecious. *Stipulodes* in a single row, small, blunt. *Stem-cortex* diplostichous, primary and secondary cell-series equally developed. *Spine-cells* absent. *Branchlets* ecorticate, strongly incurved, consisting of 5 articulations. *Bract-cells* absent. *Bracteoles* ½ to 1½ times the length of the oogonia. ♂ and ♀ *gametangia* at the two lowest branchlet-nodes, solitary. *Oospores* black, 700 μ long, 450 μ wide with 11—12 ridges, terminating in short basal claws.

Remarks. The species is very closely allied to *Chara fibrosa*, and has probably to be regarded as a subspecies thereof. The short diagnosis given above is from the type description, as I did not see a specimen.

Ecology. In shallow drains and marshy land at an altitude of 900 m and more. The species is very brittle and whitish due to heavy incrustation. The seasonal distribution is from September to December.

It is found together with *Chara Grovesii*, *C. Handae*, and *C. brachypus*.

Distribution. 22° N.; ASIA, India: Burma.

2. Series GYMNOPODES A. BRAUN in HOOKER's Journ. Bot. 1, 1849, p. 202; id., id., p. 297.

Lowest articulation of the branchlets always destitute of cortical-cells.

12. Chara hydropitys REICHENBACH *apud* MOESSLER, Gemeinn. Handb. d. Gewächsk., 3, ed. 3, 1834, p. 1670; A. BRAUN in HOOKER's Journ. Bot. 1, 1849, p. 297; WALLMAN in Act. Soc. Linn. Bordeaux 21, 1856, p. 55; A. BRAUN in Monatsber. Kön. Akad. Wiss. Berlin f. 1867, p. 799, 1868 (*nom. tant.*); BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, pp. 19, 133; T. F. ALLEN, Charac. Americ. 1, 1888, p. 56 (*nom. tant.*); H. & J. GROVES in URBAN, Symb. Antill. 7, 1911, p. 39; NORDSTEDT in Proc. Roy. Soc. Vict., N.S. 31, 1918, p. 5 (*nom. tant.*); G. O. ALLEN in Journ. Bombay Nat. Hist. Soc. 30, 1925, p. 597; J. GROVES in Journ. Linn. Soc., Bot., 48, 1927, p. 135; GROVES & ALLEN in Journ. Bot. 55, 1927, p. 339; G. O. ALLEN in Journ. Ind. Bot. Soc. 7, 1928, p. 62; ZANEVELD in Blumea 3, 1939, pp. 381, 382 — ? *Chara nudipes* WALLMAN in Kon. Vet. Akad. Handl. 40, 1854, p. 293 — ? *Chara longibracteata* SALZMANN (non KUETZING), Pl. venal. Brasil. 1830, No. 743.

Illustrations. T. F. ALLEN, Americ. Charac. 1, 1888, f. 51 (var. *majuscula*).

Plant monoecious, yellowish brown-green, heavily covered with clay, up to 19 cm high. *Stem* rather slender, c. 450 μ in diam. *Internodes* as long as or somewhat shorter than the branchlets. *Cortex* diplostichous, though in some plants triplostichous, the primary series

more prominent than the secondary one. *Spine-cells* small and few, solitary, up to 199 μ long, acute. *Stipulodes* forming a single whorl, twice as numerous as the branchlets, acute, c. 375 μ long, c. 75 μ wide (maximum resp. 980 μ and 200 μ). *Branchlets* 8—13, up to 12 mm long, consisting of 5—7 articulations, of which the lowest and two or three terminal ones are ecorticate (in some of the branchlets, however, the cortex is sometimes not present at all). *Bract-cells* 4—6, acute, variable in length, the anterior pair equal to twice the length of the ripe oogonium. *Bracteoles* similar to the bract-cells, 1—1½ times the length of the oogonium. ♂ and ♀ *gametangia* at the lowest 3—5 nodes, solitary, at the same nodes. *Antheridia* 210—450 μ in diam. *Oogonia* 350—750 μ long (incl. coronula), 280—500 μ wide; *spiral-cells* showing 11—14 convolutions; *coronula* 50—105 μ high, 100—140 μ wide at base; *oospores* black, 280—530 μ long, 220—380 μ wide, with 9—13 ridges.

Remarks. *Chara hydropitys* is a well distinguishable species, being the only one belonging to the *Haplostephanae* with the branchlets partially corticated. The always ecorticate first branchlet-articulation is also found in a member of the *Diplostephanae*, i. e. *C. zeylanica*, which, however, differs in many other respects.

The species has a wide distribution but it has not been recorded from Europe and Australia. The size of the ripe oospores is much greater in the Asiatic plants than in those from other regions.

BRAUN (1882, p. 133—137) distinguished six varieties, and though I did not see many specimens it may be useful to give a survey of their characters and synonyms taken from the type descriptions (table XV).

It follows from the table that some of the varieties can hardly be maintained as they are different only in the number of corticate articulations and we may expect that more intermediate plants will be found. This is, moreover, clearly demonstrated by ROBINSON (1906), who writes (on p. 274) that *C. mexicana* has two or three corticate branchlet-internodes; in his key, however, it is placed under "Leaves with one corticated internode". It has therefore to be placed between *C. Liebmannii* and *C. Robbinsii*, but then both species merge gradually into each other. I therefore agree with GROVES (1911, p. 39) in considering them as synonyms.

Ecology. This tender looking species with the partly corticate branchlets occurs in shallow water of "quickly drying" up road-side ponds and rice-fields. According to G. O. ALLEN (1928, p. 66) it is,

in Saharanpur, mainly growing by itself in small scattered, spreading clumps, but here and there mixed up with *Chara zeylanica*. Notes on

TABLE XV.

Characters / Varieties of *C. hydropitys* A. Br.	Number of branchlets per whorl	Length of oospore in μ	Number of corticate articulations	Literature and synonyms
indica A. Br.	9–13	280—350	3—4	cf. below
genuina A. Br.	9—13	360–400	1–3	Braun (1858, p. 359) Braun & Nordstedt (1882, p. 134) T. F. Allen (1888, p. 56)
perfecta A. Br	9–13	360–400	4	Braun & Nordstedt (1882, p. 133) T. F. Allen, (1888, p. 56) *C. Liebmannii* Robinson (1906, p. 274)
majuscula Nordst.	9–13	400–530	1—5	Braun & Nordstedt (1882, p. 134) *C. Robbinsii* Halsted *p. p.* (1879, p. 183) *C. hydropitys* v. *septentrionalis* Nordst. ex T. F. Allen (1888, p. 56) *C. hydropitys* v. *mexicana* T. F. Allen (1893, p. 120) *C. Schneckii* Robinson (1906, p. 271) *C. mexicana* Robinson (1906, p. 274)
africana A. Br.	8—9	330 380	1—2	Braun & Nordstedt (1882, p. 135) T. F. Allen (1888, p. 56)
brachypitys A. Br.	8–9	580–620	0—3	Braun & Nordstedt (1882, p. 136) T. F. Allen (1888, p. 56)

the labels give furthermore *Chara corallina, C. fibrosa* ssp. *gymnopitys, Nitella acuminata* and *N. bipartita* as inhabitants of the same localities.

PAL (1932, p. 51) remarks that *C. hydropitys* is restricted to flat country and this agrees very well with the field annotations.

Ripe oospores are found from June to March.

Distribution. Between 42° N. and 30° S.; ASIA, India: Ceylon; Malaysia, cf. var. *indica*. Moreover in lit.: India: Gangetic Plain, GROVES & ALLEN (1927, p. 373), ALLEN (1928, p. 63), Coromandelia, ALLEN (1928, p. 63), Bengal, AGHARKAR & KUNDU (1937, p. 17) — AMERICA, N. Am.: United States, ROBINSON (1906, pp. 271, 276); C. Am.: Mexico, BRAUN & NORDSTEDT (1882, p. 133), T. F. ALLEN (1893, p. 120), ROBINSON (1906, p. 274); S. Am.: Surinam, BRAUN (1858, p. 359), BRAUN & NORDSTEDT (1882, p. 134); BRAZIL, BRAUN & NORDSTEDT (1882, p. 136) — AFRICA, N. Afr.: Egypt, BRAUN & NORDSTEDT (1882, p. 136).

var. α **indica** A. BRAUN in HOOKER's Journ. Bot. 1, 1849, p. 297; BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, pp. 19, 135; T. F. ALLEN, Charac. Americ. 1, 1888, p. 56 (*nom. tant.*) — *Chara hydropitys* REICHB. in J. GROVES in Journ. Linn. Soc., Bot., 46, 1922, p. 102; id. in Journ. Linn. Soc., Bot., 46, 1924, pp. 363, 373; PAL in Journ. Burma Res. Soc. 18, 3, 1929, p. 113 (*nom. tant.*); id. in Journ. Linn. Soc., Bot., 1932, pp. 65, 81; AGHARKAR & KUNDU in Journ. Dep. Sci., N. S. 1, 1937, pp. 11, 16.

Illustrations. AGHARKAR & KUNDU, Journ. Dep. Sci., N. S. 1, 1937, pl. 8, f. 3.

Plant varying in height, usually more than 10 cm, however, in some plants not more than 5 cm. *Branchlets* 9—13 in a whorl, composed of 6—7 articulations of which the lowest and two or three of the uppermost ones are ecorticate, whereas in some whorls some of the branchlets are entirely destitute of a cortex. The lowest articulation is about half as long as the succeeding ones. The corticate articulations have the cortical-cells in a double series. *Spine-cells* usually very small or rudimentary. *Oospores* 280—350 μ long, 220—260 μ wide.

Remarks. This variety can be subdivided into three more or less distinct forms, though intermediates occur. Its principal characters are: the small ripe oospore and the high number of branchlets. It is restricted to Asia only.

Distribution. Between 27° N. and 10° S.; ASIA, India; Siam; Malaysia; cf. formae. Moreover in lit.: India: Ceylon, BRAUN & NORDSTEDT (1882, p. 135), GROVES (1922, p. 102); Gangetic

Plain, GROVES (1924, p. 373), ALLEN (1925, p. 597), Burma, PAL (1932, p. 82).

f. 1. **major** A. BRAUN in HOOKER's Journ. Bot. 1, 1849, p. 297.

Illustrations. The pres. paper, figs. 18*a*—*c*.

Plants 5—10 cm high, otherwise identic with the variety *indica*.

INDIA: Assam, without exact locality and date, JENKINS s.n., herb. HOOKER in (B), *type* of var. *indica* and of f. *major*; ibid., without exact locality and date, no collector's name, herb. HOOKER in (B), together with *Chara brachypus*.

SIAM: Pak Raw, inside channel, between two parts of Talé Sap (water brackish, 4—6 m), 25 I 1916, ANNANDALE 15 (Si), together with *Chara corallina* and *C. zeylanica*.

MALAY PENINSULA: Perak, N. of Grik, from a small pool in a little stream, 17 VI 1924, BURKILL 12417 (Si).

JAVA: Buitenzorg, Tegal Sapi, 240 m alt., in rice-fields, 27 VII 1922, BAKHUIZEN VAN DEN BRINK fil. 1512 (Bz, L), mixed up with *Chara fibrosa* ssp. *gymnopitys*.

MADOERA: E. N. E. of Sampang, 25 m alt., in rice-fields, 5 III 1915, BACKER 19781a (Bz).

SUMATRA: Palembang, Lake Ranau, alt. 560 m, in a rice-field at the south border, German Limnol. Sunda Exp. RSaβ, 27 I 1929, (Bu-Mus), two dried specimens both determined by FILARSZKY (1934, p. 706) as *Nitella bipartita* n.sp.. In a little bottle are fragments on formalin with the same annotation, however, these belong to *Nitella acuminata* and *N. bipartita*. The dried specimens are not mixed up.

PHILIPPINE ISLANDS: Luzon, Prov. of Rizal, X—XI 1916, RAMOS, Bur. of Sci. 26748 (Bz, K, L, Si).

Distribution. Between 27° N. and 10° S.; ASIA, India; Siam; Malaysia.

f. 2. **minor** A. BRAUN in HOOKER's Journ. Bot. 1, 1849, p. 297 — *Chara chamaepitys* A. BRAUN in lit. and in herb. (B) — *Chara hydropitys* REICHENBACH var. *indica* A. BR. f. *pumila* A. BRAUN in herb. (B).

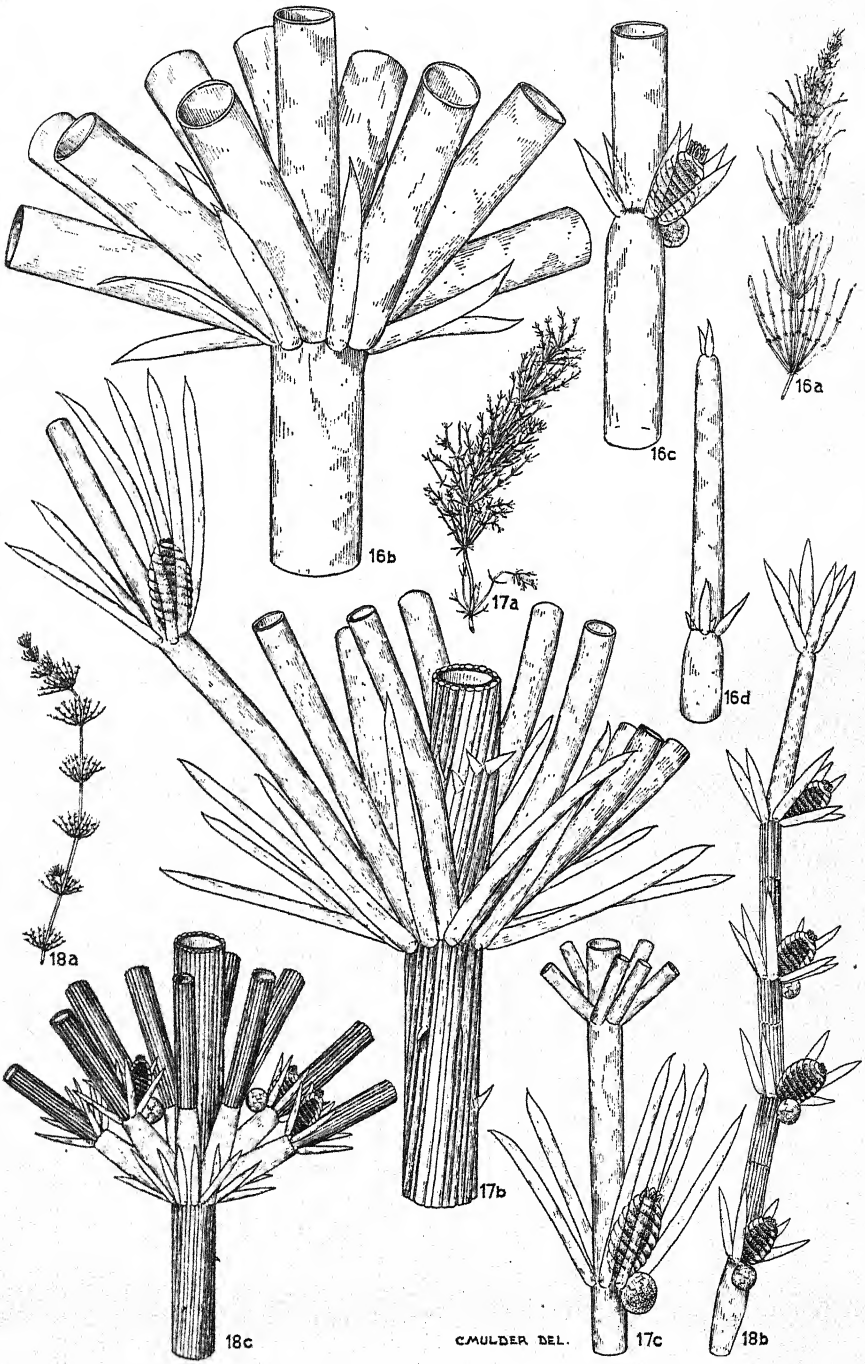
Plants up to 5 cm high, otherwise identic with the variety.

INDIA: Coromandelia, Coromandelian coast, 1826—1828, BÉLANGER 4 ? (B), *type*.

Remarks. Extremely small specimens which are at once distinguishable by their small habit.

Fig. 16, *Chara Braunii* var. *oahuensis* f. *javanica*; *a*. habit, nat. size; *b*. stem-node, × c. 15; *c*. fertile branchlet-node, × c. 15; *d*. apex of branchlet, × c. 18 — Fig. 17, *Chara fibrosa* ssp. *flaccida*; *a*. habit, nat. size; *b*. stem-node, × c. 20; *c*. part of fertile branchlet, × c. 22 — Fig. 18, *Chara hydropitys* f. *major*; *a*. habit, nat. size; *b*. fertile branchlet, × c. 10; *c*. stem-node, × c. 14 (the bract-cells on the branchlet-nodes in the middle of the figure are omitted).

Pl. 5



Distribution. Between 10° N. and 25° N.; ASIA, Coromandelia.

f. 3. **gymnophylla** A. BRAUN in HOOKER's Journ. Bot. 1, 1849, p. 297.

Plants similar to f. *major*, but most of the branchlets ecorticate. However, in the same specimens some of the whorls or some branchlets of a whorl are provided with a cortex.

INDIA: Bengal, Busna, VIII 1837, no collector's name, herb. HOOKER in (B), *type*; ibid., between Kissengunge and Titalya, in waters along the road, X 1868, KURZ s.n. (B).

Remarks. This form is remarkable as it forms a transition into *Chara fibrosa*, in which the branchlets are always partly corticate.

Distribution. C. 25° N.; ASIA: India: Bengal.

II. Sectio DIPLOSTEPHANAE A. BRAUN in N. Denkschr. Schweiz. Ges. Naturw. 10, 1849, p. 13; id. in HOOKER's Journ. Bot. 1, 1849, p. 203; id., id., p. 298; VON LEONHARDI in Verh. naturf. Ver. Brünn 2, 1864, repr. p. 41; A. BRAUN, Consp. syst. Charac. europ., 1867, p. 4; id. in Monatsber. Kön. Akad. Wiss. Berlin f. 1867, p. 199, 1868; id. in COHN, Krypt. Fl. Schles. 1, 1876, p. 404; BRAUN & NORDSTEDT, in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 19; T. F. ALLEN, Charac. America 1, 1888, p. 57; H. & J. GROVES in URBAN, Symb. Antill. 7, 1911, p. 31; NORDSTEDT in Proc. Roy. Soc. Vict. 31, N. S., 1918, p. 5; GROVES & BULLOCK WEBSTER, Brit. Charoph. 2, 1924, p. 14; J. GROVES in Journ. Linn. Soc., Bot., 46, 1924, p. 363; PRINTZ in ENGLER & PRANTL, Nat. Pfl. fam. 3, ed. 2, 1927, p. 429; G. O. ALLEN in Journ. Ind. Bot. Soc. 7, 1928, p. 60; PAL in Journ. Linn. Soc., Bot., 49, 1932, p. 65; GROVES & ALLEN in Proc. Roy. Soc. Queensl. 46, 1935, p. 57; ZANEVELD in Blumea 3, 1939, p. 381 — *Chara* subgen. *Euchara* VON LEONHARDI in Lotos 13, 1863, repr. p. 14 — *Chara* sect. *Euchara* VON LEONHARDI in Verh. naturf. Ver. Brünn 2, 1864, repr. p. 41.

Stipulodes in a double whorl, frequently both rows well developed, however, sometimes one or both rows reduced.

Key to the subsections.

1a. Cortical cell-rows of the stem as numerous as the branchlets . . . . . I. HAPLOSTICHAE

b. Cortical cell-rows of the stem twice as numerous as the branchlets . . . . . II. DIPLOSTICHAE

c. Cortical cell-rows of the stem thrice as numerous as the branchlets . . . . . III. TRIPLOSTICHAE

I. Subsectio HAPLOSTICHAE A. BRAUN, Consp. syst. Charac. europ., 1867, p. 4; id. in Monatsb. Kön. Akad. Wiss. Berlin f. 1867, p. 799, 1868; BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 19; T. F. ALLEN, Charac. America 1, 1888, p. 58; HY in Bull. Soc. bot. France 60, 1913, Mém. 26, p. 28; GROVES & BULLOCK WEBSTER, Brit. Charoph. 2, 1924, p. 14; J. GROVES in Journ. Linn. Soc., Bot., 46, 1924, p. 363; PRINTZ in ENGLER & PRANTL, Nat. Pfl. fam. 3, ed. 2, 1927, p. 429; ZANEVELD in Blumea 3, 1939, p. 381 — *Chara* subsect. *corticatae isostichae* A. BRAUN in N. Denkschr. Schweiz. Ges. Naturw. 10, 1849, p. 13; id. in HOOKER's Journ. Bot. 1, 1849, p. 203; VON LEONHARDI in Verh. naturf. Ver. Brünn 2, 1864, p. 42; A. BRAUN in Krypt. Fl. Schles. 1, 1876, p. 404.

Rows of cortical-cells of the stem as numerous as the branchlets; rows of secondary cortical-cells lacking.

13. Chara canescens [1]) LOISELEUR, Not. Pl. aj. Fl. France, 1810, p. 139; ROBINSON in Bull. New York Bot. Gard. 4, 1906, p. 262; GROVES in Journ. Linn. Soc., Bot., 46, 1924, p. 373; GROVES & BULLOCK WEBSTER, Brit. Charoph. 2, 1924, p. 14, pl. 27 — *Chara crinita* WALLROTH, Ann. Bot., 1815, p. 190, pl. 3; BRAUN in Abh. Kön. Akad. Wiss. Berlin, 1856, p. 338; KUETZING, Tab. Phyc. 7, 1857, p. 27, pl. 69, f. 1; BRAUN in Monatsb. Kön. Akad. Wiss. Berlin f. 1867, p. 829, 1868; T. F. ALLEN in Bull. Torrey Bot. Cl. 2, 1871, p. 10; HALSTED in Proc. Boston Soc. Nat. Hist. 20, 1879, p. 181; BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, pp. 20, 137, pl. 7, figs. 221—222; T. F. ALLEN in Bull. Torrey Bot. Cl. 9, 1882, p. 40, pl. 18; id., Charac. America 1, 1888, p. 58 (*nom. tant.*); MIGULA, Die Charac., 1897, p. 348, figs. 87—90; HOLTZ in Mitt. Naturw. Ver. Neuvorpomm. u. Rügen 37, 1905, p. 41; PETKOFF, Charac. Bulgar., Rev. Ac. Bulgare Sci., 1914, p. 7; id. in Ann. Univ. Sofia, 1922, p. 1; ERNST in Zeitschr. ind. Abst. u. Vererb. Lehre 17, 1917, p. 203; id., ibid. 16, 1921, p. 144 and 25, 1921, p. 185; WINKLER, Verbr. u. Urs. d. Parthenog., 1920, p. 3; STROEDE, Oekol. d. Charac., 1931, p. 47.

Plant dioecious. *Stem* moderately stout, 800—900 μ in diam. *Internodes* 2—4 times the length of the branchlets. *Stem-cortex* haplostichous. *Spine-cells* very well developed, solitary or in clusters, frequently 2—5 together, 1—3 times as long as the diam. of the stem. *Stipulodes* in a double whorl, acuminate, cells of the upper whorl usually somewhat longer than those of the lower one. *Branchlets* 8—11 in a whorl, composed of 5—8 articulations, of which the upper one is ecorticate, the other ones haplostichous corticate. *Bract-cells* 5—6, slightly longer than the oogonium. *Bracteoles* similar to the bract-cells. *Bractlet*, taking the place of the antheridium, rudimentary. ♂ and ♀ *gametangia* solitary or

[1]) An extensive list of synonyms, not seen by the writer, figures and European literature are to be found in MIGULA (1897, p. 348) and in GROVES & BULLOCK WEBSTER (1924, p. 14).

geminate at the lowest 2—4 branchlet-nodes. *Antheridia* 560—700 μ in diam. *Oogonia* 550—850 μ long (excl. coronula), 360—550 μ wide; *spiral-cells* showing 13—15 convolutions; *coronula* 50—80 μ high, 100—150 μ wide at base, individual cells blunt; *oospores* black, 350—625 μ long, 225—400 μ wide, with 10—13 inconspicuous ridges, terminating in short basal claws.

Remarks. *Chara canescens* is mainly distributed in Europe, and is the only haplostichous member of the *Diplostephanae* in India. It is very remarkable for its parthenogenetic reproduction. According to MIGULA (1897, p. 357) male plants are only found in Romania, in France, in Greece, in the Caspian Sea, but the Greek record is doubtfull (cf. GROVES & BULLOCK WEBSTER, 1924, p. 17), and, according to PETKOFF (1914, 1922), in Bulgaria and to HOLTZ (1905, p. 43) in Hungary and Italy. In Sicily ♂ and ♀ plants have been found. This problem was first studied by BRAUN (1856) and was afterwards subject of extensive experiments by DE BARY (1871, 1875), WINKLER (1920), and ERNST (1917, 1921). No Indian specimens seen.

Ecology. The water in which *C. canescens* occurs is always brackish or saline. In Germany the minimum Cl-content is 1000 mg per liter, and the max. value is 19000 mg, i.e. in the Skagerrak, according to STROEDE (1931, p. 47). In Africa it is also found "in brakischem Wasser" (BRAUN, 1868, p. 830) and in America in slightly brackish water (ALLEN, 1882, p. 41), but, when an inlet was opened and the pond has become nearly as salt as the sea, the plant disappeared.

The species is mostly found on sand destitute of organic substances.

In Germany it grows often together with *Tolypella nidifica* and *Chara aspera*.

Distribution. Between 43° N. and 20° N.; EUROPE: cf. BRAUN & NORDSTEDT (1882, p. 138), MIGULA (1897, p. 359), GROVES & BULLOCK WEBSTER (1924, p. 16); ASIA: Arabia, BRAUN (1868, p. 830); the Urals, Afghanistan, Mongolia, China, BRAUN & NORDSTEDT (1882, p. 138); India: Baluchistan, BRAUN & NORDSTEDT (1882, p. 138), GROVES (1924, p. 373) — AFRICA, N. Afr.: Algeria, BRAUN (1868, p. 830); Egypt, BRAUN & NORDSTEDT (1882, p. 138) — AMERICA, N. Am.: Long Island, ALLEN (1871, p. 10; 1884, p. 40), BRAUN & NORDSTEDT (1882, p. 139); Massachusetts, ROBINSON (1906, p. 263).

II. Subsectio DIPLOSTICHAE A. BRAUN, Consp. syst. Charac. europ., 1867, p. 5; id. in Monatsber. Kön. Akad. Wiss. Berlin f. 1867, p. 800, 1868; id. in COHN, Krypt. Fl. Schles. 1, 1876, p. 404; BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 20; T. F. ALLEN, Charac. America 1, 1888, p. 58; HY in Bull. Soc. bot. France 60, 1913, Mém. 26, p. 29; NORDSTEDT in Proc. Roy. Soc. Viet. 31, N.S., 1918, p. 5; GROVES & BULLOCK WEBSTER, Brit. Charoph. 2, 1924, p. 18; J. GROVES in Journ. Linn. Soc., Bot., 46, 1924, p. 363; PRINTZ in ENGLER & PRANTL, Nat. Pfl. fam. 3, ed. 2, 1927, p. 429; GROVES & ALLEN in Proc. Roy. Soc. Queensl. 46, 1935, p. 57; ZANEVELD in Blumea 3, 1939, p. 381 — *Chara* subsect. *Corticatae diplostichae* A. BRAUN in N. Denkschr. Schweiz. Ges. Naturw. 10, 1849, p. 13; id. in HOOKER's Journ. Bot. 1, 1849,

p. 203; id., id., p. 298; VON LEONHARDI in Verh. naturf. Ver. Brünn 2, 1864, p. 43.

Rows of cortical-cells of the stem twice as numerous as the branchlets; between two successive primary rows of cortical-cells one secondary row is produced.

Key to the series.

1a. Primary cortical-cells more prominent than the secondary ones, therefore spine-cells appear to be situated on ridges . . . . 1. TYLACANTHAE
b. Secondary cortical-cells more prominent than the primary ones, therefore spine-cells appear to be situated in furrows . . . . 2. AULACANTHAE

1. Series TYLACANTHAE A. BRAUN in COHN, Krypt. Fl. Schles. 1, 1876, p. 404 [1]); BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 20; T. F. ALLEN, Charac. America 1, 1888, p. 58; HY in Bull. Soc. bot. France 60, 1913, Mém. 26, p. 28; NORDSTEDT in Proc. Roy. Soc. Vict. 31, N. S., 1918, p. 6; GROVES & BULLOCK WEBSTER, Brit. Charoph. 2, 1924, p. 33; J. GROVES in Journ. Linn. Soc., Bot., 46, 1924, p. 363; PRINTZ in ENGLER & PRANTL, Nat. Pfl. fam. 3, ed. 2, 1927, p. 429.

Primary cells of the cortex more prominent and larger than the secondary ones, therefore spine-cells apparently situated on ridges.

14. Chara Grovesii PAL (non *N. Grovesii* KUNDU) in Journ. Linn. Soc. Bot. 49, 1931, p. 85, pl. 17.

Plant monoecious. *Stem* moderately stout, 450—700 μ in diam. *Internodes* 1—5 times the length of the branchlets. *Stem-cortex* diplostichous, exhibiting strong torsion, cells of the primary series more prominent than the secondary ones. *Spine-cells* papilliform. *Stipulodes* in a double whorl, well developed, blunt and unequal in length. *Branchlets* 9—11 in a whorl, ecorticate, composed of 5—6 articulations. *Bract-cells* usually 5, the lateral ones often $^1/_3$ the length of the entire oogonium. *Bracteoles* longer than the oogonia. ♂ and ♀ *gametangia* together at the two lowest nodes, solitary. *Antheridium* 450 μ in diam. *Oogonia* 740 μ long (incl. coronula), 525 μ wide; *spiral-cells* showing 14—15 convolutions. *Ripe oospores* not yet collected.

Remarks. According to the author this species very much resembles *Chara contraria*, from which it can be distinguished only by its having entirely ecorticate branchlets. The mutual relations are therefore the same as for *C. vulgaris* and ssp. *squamosa*, and with reference to this *C. Grovesii* may be best regarded as a subspecies of *C. contraria*. As I did not see a specimen, I have not cited

[1]) In this article the name is spelt as "*tylacanthae*", which is most probably an orthographic error.

it in this way. The short description given above is from the type description.

Ecology. Very common in shallow drains, in streams and in pools. It emits a disagreeable odour. In its general habit it looks like a *Nitella*.

The seasonal distribution is from September to the end of November. PAL writes that it is entirely restricted to mountainous areas. It is found growing together with *Nitella superba*, *Chara burmanica*, *C. Handae* and *C. brachypus*.

Distribution. 22° N.; ASIA, India: Burma.

15. Chara contraria KUETZING[1]), Phyc. germ. 1845, p. 258; id., Spec. Alg. 1849, p. 523; BRAUN in N. Denkschr. Schweiz. Ges. Naturw. 10, 1849, p. 15; WALLMAN in Act. Soc. Linn. Bordeaux 21, 1856, p. 64; KUETZING, Tab. Phyc. 7, 1857, pl. 61 (the oogonia have but 3 coronula cells!); BRAUN, Consp. syst. Charac. europ. 1867, p. 6; id. in HOOKER, Handb. New Zealand Flor. 1867, p. 550; id. in Monatsber. Kön. Akad. Wiss. Berlin f. 1867, p. 833, 1868; HALSTED, Classif. and Descr. Americ. spec. Charac., 1879, p. 187; BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, pp. 20, 141; SYDOW, Bish. bek. Europ. Charac., 1882, p. 57; T. F. ALLEN, Americ. Charac. 1, 1888, p. 58 (*nom. tant.*); MIGULA, Die Charac., 1897, pp. 432, figs. 99—104; id., Syn. Charac. europ., 1898, p. 96, figs. 84—89; ROBINSON in Bull. New York Bot. Gard. 4, 1906, pp. 265, 266; SLUITER in Bot. Zeit. 68, 1910, p. 125, pl. 4, figs. 1—5 and text-figs. 1—9; NORDSTEDT in Proc. Roy. Soc. Vict. 31, N.S., 1918, p. 6 (*nom. tant.*); GROVES in Journ. Linn. Soc., Bot., 46, 1924, pp. 363, 374; GROVES & BULLOCK WEBSTER, Brit. Charoph. 2, 1924, p. 36, pl. 33 (f. 9 is var. *hispidula*); G. O. ALLEN in Journ. Bombay Nat. Hist. Soc. 30, 1925, p. 597; id. in Journ. Ind. Bot. Soc. 7, 1928, p. 64; STROEDE, Oekol. d. Charac. 1931, p. 42; G. O. ALLEN in Journ. Ind. Bot. Soc. 12, 1933, p. 17; GROVES & ALLEN in Proc. Roy. Soc. Queensl. 46, 1935, p. 57; FILARSZKY in Math. u. Naturw. Anz. Ungar. Ak. Wiss. 50, 1937, p. 484; VERDAM in Blumea 3, 1938, p. 16; HASSLOW in Bot. Not. Lund, 1939, pp. 296, 297, 298.

Plant monoecious, greyish-green, usually heavily incrusted, 20—30 cm high. *Stem* varying in diam., c. 750 μ. *Internodes* 2—4 times the length of the branchlets. *Stem-cortex* diplostichous, cells of the primary series more prominent than the secondary ones. *Spine-cells* solitary, obtuse, usually short and inconspicuous, however, in the var. *hispidula* once to twice as long as the diam. of the stem. *Stipulodes* in a double whorl, two pairs to each branchlet, usually short and sometimes almost spherical, irregular. *Branchlets* 6—10 in a whorl, consisting of 5—7 articulations, of which the upper 2—3 are ecorticate, the other ones diplostichous corticate, 0.5—3 cm long. *Bract-cells* usually 5, varying in length, the anterior pair equal or much longer than the oogonium, the lateral ones and the posterior cell mostly reduced to papillae. *Bracteoles* somewhat longer than the anterior bract-cells, 0.6—3 cm long. ♂ and ♀ *gametangia* solitary or rarely geminate (ROBINSON, 1906, p. 265), at the same 2—4 lowest nodes. *Antheridium* 300—450 μ in diam. *Oogonia* 650—1100 μ long (incl. coronula), 500—650 μ wide; *spiral-cells* showing 13—15 convolutions; *coronula* 120—190 μ high, 220—360 μ

[1]) Only the principal European literature is cited here; for a full list (incl. the varieties) I refer to MIGULA (1897, pp. 432—433), and GROVES & BULLOCK WEBSTER (1924, pp. 36—37).

wide at base, individual cells oblong, blunt at the apex, somewhat spreading; *oospores* black, 500—720 μ long, 350—490 μ wide, with 10—14 fine ridges, prolonged downwards into a cage; *outer membrane* yellow or golden-brown, granulate, with c. 6 granules per 10 μ.

CHINA: Kweichow, without exact locality, submerged in rice-fields and streams, 900 m alt., 5 VIII 1931, LIANG FEN YAH and TSUN YI HSIEN, Pl. of Kweichow 186 (L).

Remarks. The variability of this species, though less pronounced than in *C. vulgaris* has been a subject for many subdivisions. BRAUN's division into two varieties (1849, p. 16) i.e. *hispidula* with, and *moniliformis* without distinctly developed spine-cells, are found back in the arrangements of SYDOW (1882, pp. 57—58) and MIGULA (1897, p. 432). Some of the authors, however, regard these varieties as series. An extensive survey of the literature regarding this subject is to be found in Miss SLUITER's "Beiträge zur Kenntnis von *Chara contraria* A. BR. und *Chara dissoluta* A. BRAUN" (1910, p. 125).

GROVES & BULLOCK WEBSTER (1924, p. 36, 40) regard all plants with short and inconspicuous spine-cells as belonging to the species *C. contraria* proper, and they put all specimens with well developed spines together in the var. *hispidula*.

The present author shares BRAUN's first opinion, the plants mentioned in the exsiccatae therefore belong to the var. *moniliformis*.

Most probably the plants described as var. *australis* A. BR. and var. *Behriana* A. BR., both occurring in Australia belong also to the var. *moniliformis*, from which they can be distinguished by the larger oospore. Without having seen the types this cannot be decided with certainty.

Sometimes, *C. contraria* is hardly distinguishable from *C. vulgaris* though the typical specimens are characterized by the greater prominence of the primary cortical cell-series, so that the spine-cells are situated on ridges, by the much darker ripe oospores, and by the somewhat irregular stipulodes. It is a cosmopolitan species, but as yet it has not been collected in Malaysia.

Ecology. *Chara contraria* is a small to medium-sized plant, much incrusted with lime. According to STROEDE (1931, p. 43) it is in Germany only found in anorganotrophic waters of which the pH is c. 7.0. This water may be fresh or brackish, as the Cl-concentration may be rather high, varying from 25 to 3535 mg per liter. BRAUN & NORDSTEDT (1882, p. 142) record the plant from valleys in Songaria with a high percentage of salt.

Sandy bottoms are preferred by this species, and it occurs most frequently at a greater depth, c. 1—2 m, than *C. vulgaris*. Therefore, it is especially found in lakes and in larger water basins than the last named species. It is growing in the lowlands as well as in mountainous areas; in the Swiss Alps it is found at an elevation of 2000 m.

G. O. ALLEN (1928, p. 64) writes that in Saharanpur, *C. contraria* is a distinctly cold weather type; it does not seem to germinate before the middle of November, and disappeares at the end of April.

C. contraria, as *C. vulgaris*, commonly occurs in dense masses with little or no intermixture of other plants. However, in the vicinity *Chara tomentosa*, *C. aspera* and *C. globularis* are often to be found, and according to STROEDE, such

higher plants are present, as *Hypnum scorpioides*, *Potamogeton gramineus*, *Potamogeton Zizii*. In brackish water it grows together with *C. baltica*.

Distribution. Between 70° N. and 50° S.; Asia, China. Moreover in lit.: Europe, cf. Braun & Nordstedt (1882, pp. 141—142); Migula (1887, pp. 441—442); Groves & Bullock Webster (1924, p. 38) — Asia, Songaria, Braun & Nordstedt (1882, p. 142); India: W. and E. Himalaya, India Deserta, Malabaria, Burma, Groves (1924, p. 374), Gangetic Plain, Groves (1924, p. 374), Allen (1925, p. 597; 1928, p. 64; 1933, p. 17; 1936, p. 51) — America, N. Am.: Alaska, Quebec, Robinson (1906, p. 265); United States: Montana, Nebraska, Michigan, New York, Missouri, Braun & Nordstedt (1882, pp. 143—145), Robinson (1906, p. 296); Texas; C. Am.: Mexico, Braun & Nordstedt (1882, pp. 143—145); S. Am.: Bolivia, Braun & Nordstedt (1882, p. 145); Argentine, Nordstedt (1888, p. 191) — Africa, N. Afr.: Algeria, Braun (1868, p. 833); Egypt, Braun & Nordstedt (1882, p. 142); S. Afr.: Cape Colony, Braun (1868, p. 834) — Australia, W. Austr.: ex Groves & Allen (1935, p. 58); S. Austr.: Braun (1852, p. 709); Nordstedt (1882, p. 36); Kangaroo Islands, Queensland, Groves & Allen (1935, p. 57); New South Wales, Victoria, Nordstedt (1889, p. 36); Tasmania, Braun & Nordstedt (1882, p. 143); New Zealand, Braun (1867, p. 550); Braun & Nordstedt (1882, p. 143).

2. Series Aulacanthae A. Braun in Cohn, Krypt. Fl. Schles. 1, 1876, p. 406; Braun & Nordstedt in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 21; T. F. Allen, Charac. America 1, 1888, p. 59; Hy in Bull. Soc. bot. France 60, 1913, Mém. 26, p. 28; Nordstedt in Proc. Roy. Soc. Vict. 31, N.S., 1918, p. 6; Groves & Bullock Webster, Brit. Charoph. 2, 1924, p. 18; J. Groves in Journ. Linn. Soc., Bot., 46, 1924, p. 363; Printz in Engler & Prantl, Nat. Pfl. fam. 3, ed. 2, 1927, p. 429.

Secondary cells of the cortex more prominent and larger than the primary ones, therefore spine-cells apparently situated in furrows.

16. Chara vulgaris Linnaeus, Spec. Plant., 1753, p. 1156, *pro parte* — *Chara foetida*; *C. foetida* ssp. *gymnophylla*; *C. gymnophylla*; *C. gymnophylla algeriensis*; *C. squamosa*; cf. subspecies.

Plant monoecious, greyish green, usually heavily incrusted, very much varying in length, usually c. 25 cm high. *Stem* moderately stout, c. 500 μ in diam. *Internodes* c. twice as long as the branchlets. *Cortex* diplostichous, cells of secondary series more prominent than the primary ones, which collapse in a dried state. *Spine-cells* single, much varying in length, frequently obtuse, if stout slightly spreading or appressed, if papilliform spreading, situated in furrows. *Stipulodes* in a double whorl, frequently cells of both whorls equally developed or those of the lower whorl somewhat depressed, short, obtuse, appressed. *Branchlets* (6—)8(—11) in a whorl, showing 6—8 articulations of which 3—5 are usually corticate (in the ssp. *squamosa* all ecorticate) frequently incurved, however, when fully mature recurved, varying in length. *Bract-cells* 4—6, obtuse or acuminate, extremely variable in length, usually unilateral, anterior ones much longer than the oogonium, posterior ones usually not developed at all, or as long as the

oogonium, in a few cases all bract-cells equally developed, usually lacking or papilliform at the ecorticate branchlet-articulations. *Bracteoles* similar or somewhat longer than the anterior bract-cells. ♂ and ♀ *gametangia* at the same 3—4 lowest nodes, usually solitary, rarely more together, lacking at the nodes above ecorticate articulations. *Antheridia* 275—540 μ in diam. *Oogonia* 525—800 μ long, (excl. coronula), 350—475 μ wide; *spiral-cells* showing 13—16 convolutions; *coronula* 75—125 μ high, 200—325 μ wide at base, individual cells blunt, more or less spreading; oospores golden-brown or dark-brown, rarely black, 425—675 μ long, 225—400 μ wide, with 12—15 ridges often prolonged into a cage; *outer membrane* tuberculate.

Remarks. *Chara vulgaris* is a cosmopolitan species and extremely variable in all parts, most probably due to conditions of growth. This variability was reason for a subdivision of the species. A number of subspecies and nearly related species were already cited by BRAUN & NORDSTEDT (1882) and by T. F. ALLEN (1888), whereas MIGULA (1897) and GROVES & BULLOCK WEBSTER (1924) regarded some of these again as varieties or forms. As I have not seen all the types of

TABLE XVI.

Characters / Subspecies of *C. vulgaris* L.[1])	Number of ridges	Shape of bract-cells	Diam. of antheridium in μ	Number of corticate articulat.	♂ and ♀ gametangia	Distribution
squamosa (A. Br.) ZANEV.	12–14	blunt	300–360	0	conjuncted	Eur. Asia Afr.
eu-vulgaris (A. Br.) ZANEV.	id.	id.	id.	2–4	id.	Cosm.
crassicaulis (A. Br.) ZANEV.	id.	id.	420–480	2—4	id.	Eur. Afr.
Rabenhorstii (A. Br.) ZANEV.	id.	id.	480—540	2—4	disjuncted	Eur.
Boveana (A. Br.) ZANEV.	10–11	acuminate	300—360	4—6	conjuncted	Eur. Asia Afr.
capensis (A. Br.) ZANEV.	9–10	id.	id.	3—7	id.	Afr.

[1]) Whether *C. Kokeilii* A. Br. must be placed here as a subspecies or in the *Triplostichae* as a separate species is as yet uncertain.

the different forms I cannot give a decision just now. However, from the type and other descriptions found in literature I provisionally get at the subjoined statement (table XVI).

Chara vulgaris closely resembles *C. contraria*, which is different by having the primary cortical-cells more prominent than the secondary ones, thus belonging to the tylacanthous type. If many spine-cells are present, this difference is very well visible in a transverse section of the stem, as the spine-cells in the case of *C. vulgaris* are then situated on the smaller cells. Another particular of the last species is that the "NORDSTEDT-markings", the decoration of the outer coloured ripe oospore membrane, consist of separate little tubercles, c. 7 per 10 μ, whereas in *C. contraria* they show contiguous granules, c. 6 per 10 μ. The ripe oospores are black in the last-named species while those of *C. vulgaris* are golden-brown to dark-brown (only in the var. *melanopyrena* black with a brown shade). It is somewhat surprising that typical representatives of the species were not extant at all amongst the material of the Netherlands Indies.

Ecology. *Chara vulgaris* is usually a medium-sized plant with a moderately stout stem. It is usually heavily incrusted with calcium carbonate, which is frequently not in annular bands. STROEDE (1931, p. 30) did not find the species in German waters with less than 55 mg CaO per liter.

The plant occurs in bogs, ditches, at the shallow margins of ponds and lakes, in very shallow running water of rivulets, and little streams. STROEDE has found it in Germany in anorganotrophic waters only. This author has also detected the species in a little brackish water containing c. 750 mg Cl per liter. The organic substances of the muddy bottom are always less than 50 %, whereas it contains a high amount of lime. Plants with ripe oospores are found in Saharanpur from November to May. In Germany ripe oospores were found from the late summer to autumn, according to STROEDE (1931, p. 29).

C. vulgaris occurs in lowland as well as in mountainous areas; it is recorded by BRAUN & NORDSTEDT (1882, p. 159) from 2300 m in the Swiss Alps and from 4500 m in the Cordilleras of Peru (*l.c.*, p. 166). It frequently grows in pure communities by itself, as the dense masses usually oust other species. *N. clavata* is the only species recorded to be found growing together with it.

Distribution. Between 70° N. and 50° S.; occurring in all the continents.

ssp. A. **eu-vulgaris** ZANEV., nov. ssp. — *Chara vulgaris* L.[1]), Spec. Plant., 1753, p. 1156, *pro parte*; WALLROTH, Annus Botanicus, 1815, p. 179, pl. 1; WILLDENOW in Mém. Acad. Roy. Berlin f. 1803, p. 84, 1805; BRUZELIUS & FUERNROHR in Flora 9, 1826, p. 486; AGHARD, Syst. Alg. 1824, p. 128; KUETZING, Phyc. Gen., 1843, p. 319, pl. 38, 39; id., Phyc. germ., 1845, p. 258; id., Spec. Alg., 1849, p. 523; id. Tab. Phyc. 7, 1857, pl. 58—60, 72, f. 2; ROBINSON in Bull. New York Bot. Gard. 4, 1906, pp. 255, 269; GROVES in Journ. Linn. Soc., Bot., 46, 1924, pp. 363, 374; GROVES & BULLOCK WEBSTER, British Charoph. 2, 1924, p. 18, pl. 28, 29; G. O. ALLEN in Journ. Ind. Bot. Soc. 7, 1928, p. 63, pl. 2; STROEDE, Oekol. d. Charac. 1931, p. 29, pl. 2, f. 1; G. O. ALLEN in Journ. Ind.

[1]) A full list of European literature, other synonyms not examined by the writer, and illustrations are to be found in MIGULA (1897, pp. 554—556) and in GROVES & BULLOCK WEBSTER (1924, pp. 18—19).

Bot. Soc. 12, 1933, p. 17; ALLEN & HERTER in Revist. Sudamer. Bot. 1, 1934, p. 90; G. O. ALLEN in Journ. Ind. Bot. Soc. 15, 1936, p. 51; VERDAM in Blumea 3, 1938, p. 21; ZANEVELD in Blumea 3, 1939, pp. 381, 382 — *Chara foetida* A. BRAUN in Ann. Sci. Nat., Bot., 2, 1, 1834, p. 354; id. in Flora 18, 1835, p. 63; id. in HOOKER's Journ. Bot. 1, 1849, p. 298; WALLMAN in Act. Soc. Linn. Bordeaux 21, 1856, p. 63; BRAUN, Consp. syst. Charac. europ. 1867, p. 5; id. in HOOKER, Handb. New Zealand Fl., 1867, p. 550; id. in Monatsber. Kön. Akad. Wiss. Berlin f. 1867, p. 838, 1868; HALSTED in Proc. Boston Soc. Nat. Hist. 19, 1879, p. 185; BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, pp. 21, 159; T. F. ALLEN, Charac. Americ. 1, 1888, p. 59 (*nom. tant.*); NORDSTEDT in Hedwigia 70, 1888, pp. 191, 195; id. in Acta Univers. Lund. 25, 1889, p. 36; MIGULA, Die Charac., 1897, p. 554, figs. 121, 122, 124; id., Syn. Charac. europ. 1898, p. 122, figs. 106, 107, 109; NORDSTEDT in Proc. Roy. Soc. Victoria 31, N. S., 1918, p. 6 (*nom. tant.*); HASSLOW in Bot. Not. Lund, 1939, pp. 296, 299, 300.

Planta c. 25 cm alta. Caulis mediocriter robusta, 500 μ diam. *Internodia, cortex, stipulodia* et *bracteoli* eorum speciei similes. *Verticillorum ramuli* plerumque 8, articulis 6—8 quorum 2—4 ecorticatis. *Bracteae* plerumque 5, obtusae. ♂ et ♀ *gametangia* ad 4 nodos inferiores inserta, haud supra articulos ecorticata, plerumque solitaria vel 1—3 aggregata. *Antheridia* c. 360 μ diam. *Oogonia* 525—725 μ longa; oospora 425—520 μ longa, 12—14 striata.

Plant c. 24 cm high. *Stem* rather stout, c. 500 μ in diam. *Internodes, cortex, stipulodes* and *bracteoles* similar to those of the species. *Branchlets* usually 8 in a whorl, consisting of 6—8 articulations of which 2—4 are usually ecorticate. *Bract-cells* 5, obtuse. ♂ and ♀ *gametangia* together at the lowest 3 or 4 branchlet-nodes, however, not produced above ecorticate articulations. *Antheridia* c. 360 μ in diam. *Oogonia* 1—3 together, 525—725 μ long; *oospores* 425—520 μ long, with 12—14 ridges.

INDIA: W. Himalaya, Kumaon, Sariya valley, alt. 1650 m, no date, Himalayan herb., STRACHEY & WINTERBOTTOM s.n., ex herb. J. D. HOOKER in (B); Coromandelia, Jabalpur, in a brook, 1000 m alt., 21 XII 1875, KUNTZE 7282 (B), badly preserved specimen with unripe oogonia, therefore determination not certain; W. Bengal, Manbhoom, in rivulets, XII 1866, S. KURZ 1923 (B).

INDO-CHINA: Tonkin, W. Tonkin, without exact locality and date, BON 2854 (P).

Remarks. On account of its variability this subspecies is subdivided into a large number of forms. MIGULA distinguished in "Die Characeen" (1897) for Central Europe only, sixty-nine forms. The total number described nowadays is much higher than one hundred; the validity of these forms can only be proved by a separate study in which the experiment will be of great importance.

BRAUN (1868, pp. 839, 840) distinguished primarily two groups on account of the colour of the oospore, being brown or black (*Melanopyrenae*). The plants with a brown oospore were again subdivided into two series, viz.

Series I, *Subinermis*, in which the spine-cells are hardly visible even with a pocketlens, and

Series II, *Subhispida*, in which the spine-cells are usually as long as the diameter of the stem, thus visible with the naked eye.

This last series was given a subspecific rank by BRAUN in "Die Fragmente" (1882, p. 167), but as MIGULA (1897, p. 565) remarks, there are too few differences to share this opinion and it seems better to maintain BRAUN's first opinion.

MIGULA (1897, p. 565) has mainly taken over the first subdivision of BRAUN, but he unites the plants with less than two corticate branchlet-articulations and a brown oospore in a separate series, Series III, *Paragymnophyllae*.

The above cited exsiccatae have all a brown oospore and belong to BRAUN's series *subinermis*. They have well developed branchlets and bract-cells, which are 2—4 times as long as the oogonia. The number of branchlets and corticate articulations varies; the plants of KURZ and of STRACHEY & WINTERBOTTOM have 8 and 10 branchlets in a whorl respectively, whereas they have both 1—2 corticate articulations. The specimens of BON and KUNTZE have 8 and 11 branchlets respectively and also 3—4 corticate articulations. Regarding the specimen of KURZ 1923, BRAUN remarks that it possibly has been collected in Bengal. In the herb. of Berlin there were two specimens, one of which bears the note: "In rivulets of Manbhoom. W. Bengal", so that BRAUN's supposition has been right.

Ecology. Cf. the species.

Distribution. Between 70° N. and 50° S.; ASIA, India; Indo-China. Moreover in lit.: EUROPE — cf. BRAUN & NORDSTEDT (1882, pp. 159, 164, 167—170), MIGULA (1897, p. 550), GROVES & BULLOCK WEBSTER (1924, p. 20) — ASIA, Siberia, NORDSTEDT (1889, p. 36); Turkestan, HASSLOW (1939, p. 299); Songaria, Caucasus, Syria, Persia, Afghanistan, Tibet, Balutchistan, BRAUN & NORDSTEDT (1882, pp. 161, 166) — AMERICA, N. Am.: Canada, United States, C. Am.: Mexico, BRAUN & NORDSTEDT (1882, pp. 161—163), NORDSTEDT (1889, p. 37), ROBINSON (1906, p. 270), HASSLOW (1939, p. 300); S. Am.: Peru, Bolivia, Chili, Argentine, BRAUN & NORDSTEDT (1882, pp. 162, 164—166), Uruguay, ALLEN & HERTER (1934, p. 90) — AFRICA, N. Afr.: Tanger, Algeria, Egypt, Angola, BRAUN (1868, pp. 841—842); BRAUN & NORDSTEDT (1882, pp. 160, 161); S. Afr.: BRAUN (1868, p. 843), BRAUN & NORDSTEDT (1882, p. 160), NORDSTEDT (1888, p. 195); HASSLOW (1939, p. 300); Madeira, BRAUN (1868, p. 843); Madagascar, ZANEVELD (1939, pp. 381, 382) — AUSTRALIA; New Zealand, BRAUN (1867, p. 550), BRAUN & NORDSTEDT (1882, p. 162).

ssp. B. **squamosa** (DESFONTAINES) ZANEV., nov. comb.[1]) — *Chara squamosa* DESFONTAINES, Fl. Atlant. 2, 1800, p. 331; WILLDENOW in Mém. Acad. Roy. Berlin p. 1803, p. 88, 1805; id. in Spec. Plant. 4, 1805, p. 186; AGARDH, Syst. Alg., 1824, p. 127; BRAUN in Ann. Sci. Nat. Bot. 2, 1834, p. 354; id. in Flora 18, 1835, p. 61; KUETZING, Spec. Alg. 1849, p. 526; WALLMAN in Act. Soc. Linn. Bordeaux 21, 1856, p. 63; KUETZING, Tab. Phyc. 7, 1857, p. 29, pl. 72, f. 1 (var. *Fontanesiana*) — *Chara foetida* A. Br. ssp. *gymnophylla* A. BRAUN in Ann. Sci. Nat. Bot. 2, 1834, p. 354; id. in Monatsber. Kön. Akad. Wiss. Berlin f. 1867, p. 834, 1868; id. in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 166, pl. 7, figs. 236—239; T. F. ALLEN, Charac. Americ. 1, 1888, p. 59 (*nom. tant.*); NORDSTEDT in Lunds Univers. Års-skr. 25, 1889, p. 37 — *Chara gymnophylla* A. BRAUN in Flora 18, 1835, p. 62; id. in N. Denkschr. Schweiz. Ges. d. Naturw. 10, 1849, p. 13; KUETZING, Spec. Alg., 1849, p. 520; WALLMAN in Act. Soc. Linn. Bordeaux 21, 1856, p. 63;

[1]) Cf. footnote on p. 182.

VON LEONHARDI, Die Oesterr. Arml. Gew., 1864, repr. p. 63; BRAUN, Consp. syst. Charac. europ., 1867, p. 5; MIGULA, Die Characeen, 1897, p. 543, f. 120; id., Synops. Charac. europ., 1898, p. 119, f. 105; GROVES in Journ. Linn. Soc., Bot., 46, 1924, pp. 363, 374; GROVES & BULLOCK WEBSTER, Brit. Charoph. 2, 1924, p. 26; PAL in Journ. Linn. Soc., Bot., 49, 1932, p. 85; HASSLOW in Bot. Not. Lund, 1939, p. 299; DIXIT in Journ. Ind. Bot. Soc. 14, 1935, p. 260, f. 2 — *Chara gymnophylla algeriensis* KUETZING, Tab. Phyc. 7, 1857, p. 29, pl. 74, f. 2 [1]) (non KUETZING, pl. 51, f. 1).

Plant monoecious, greyish green, heavily incrusted, of variable height, c. 15 cm. *Stem* rather stout, c. 500 μ in diam. *Internodes, cortex, stipulodes* and *bracteoles* as described for the species. *Spine-cells* single, obtuse, frequently much shorter than the diam. of the stem, situated in grooves. *Branchlets* entirely ecorticate or rarely with one or two corticate articulations. *Bract-cells* blunt. ♂ and ♀ *gametangia* produced at nodes from which no cortex arises, solitary at the same nodes, or two or three (DIXIT — 1935, p. 261 — mentions 3—6) together with one or seldom two antheridia. *Antheridia* 300—400 μ in diam. *Oogonia* c. 800 μ long (excl. coronula), c. 450 μ wide; *spiral-cells* showing 13—14 convolutions; *coronula* c. 110 μ high, c. 200 μ wide at base. *Oospores* brown, 500—600 μ long, 300—350 μ wide, with 11—12 ridges.

INDIA: M a l a b a r i a, Bombay Pres., Nassik (= Nasik?) opposite the Westghats, 580 m alt., at the border of a river, 26 XII 1875, KUNTZE 7508 (B).

R e m a r k s. The only characters serving to distinguish this ssp. from *eu-vulgaris* are the gametangia, being produced at nodes from which no cortical-cells arise, whereas the branchlets are frequently entirely ecorticate. The branchlets are more or less flexible owing to the lack of cortication; the branchlet-articulations are sometimes swollen and contracted into the nodes. In the above cited plant not so a high number of oogonia was extant as was noticed by DIXIT, though a max. number of three was not rare.

BRAUN (1868, pp. 835—836) subdivided this ssp. into 4 varieties, viz. α, β *Fontanesiana*, γ *patens*, δ *pachyphloea*, all being represented in Europe, Asia and Africa, the last three varieties differing in subordinate characters from the typical one. As a synonym of var. β *Fontanesiana* is cited *Chara squamosa* DESFONTAINES, already described in 1800 (Flor. Atlant. 2, p. 331). BRAUN writes that he first did not consider this plant a synonym as the type collected in Tunis had the cells of the coronula twice as long as var. α *typica*, the spine-cells well developed and the branchlets compact and incurved. These characters are very

[1]) As BRAUN (1868, p. 834, note 1) already remarks, the *Chara* on this figure has two-celled internodes which are not known in the *Charophyta*. These can only be explained as cortical-cells originating from two whorls of initial cortical-cells belonging to the node at the base of each branchlet, one of which grows upwards and the other dwonwards, meeting each other at about the middle of an internode. This figure therefore cannot represent ssp. *squamosa*, but it is drawn after a *Chara* (possibly *C. vulgaris*) with a high number (5) of corticate branchlet-articulations and no ecorticate ones. Moreover, only the transverse cell-walls of the cortex are figured, and the longitudinal ones are not.

well figured in KUETZING's plate 72, fig. 1 (1857). Afterwards BRAUN saw more specimens, and then noticed more intermediate plants, and therefore decided to the identity of *C. squamosa* and *C. gymnophylla*. However, BRAUN does not use the older name *squamosa* as he considered it a misleading one; DESFONTAINES gave that name with reference to the spine-cells lying flat on the stem in dried plants which cause a scaly appearance. This is in contradiction with the nomenclature now adopted, reason why I have used the oldest name. Though I did not see the original plant of DESFONTAINES I examined some plants extant in the Leiden Herbarium which were determined by BRAUN himself as "*C. gymnophylla* β *Fontanesiana* (*C. squamosa*) DESF.". As these plants are quite identic with the *gymnophylla* plants I do not hesitate in considering them identic.

Ecology. In Algeria the ssp. is found in the inland waters, rivulets, swamps, as well as near the coast. In India it occurs in slowly running water. In Switzerland it is found at an elevation of 2500 m (Albula) and in the warm water of the "Leuker Bäder" in Wallis.

Characteristically it is a mediterranean plant; there it is collected with ripe oogonia from February to October. Another centre is Burma, where plants with ripe oogonia were collected in December and it mainly grows at an elevation of c. 1200 m.

Distribution. Between 50° N. and ?° S.; ASIA, India. Moreover in lit.: EUROPE — cf. BRAUN & NORDSTEDT (1882, p. 166), NORDSTEDT (1889, p. 21); MIGULA (1897, p. 550); ASIA, Caucasus, Syria, BRAUN & NORDSTEDT (1882, p. 166); Libanon, HASSLOW (1939, p. 299); China, ex GROVES (1924, p. 374); India: Bombay, DIXIT (1935, p. 261); Burma, GROVES (1924, p. 374). — AFRICA, N. Afr.: Algeria, BRAUN (1868, pp. 836, 837), NORDSTEDT (1889, p. 37), BRAUN & NORDSTEDT (1882, p. 167); Tunisia, Egypt, BRAUN (1868, pp. 836—837); S. Afr.: without exact locality, BRAUN (1868, p. 837).

III. Subsectio TRIPLOSTICHAE A. BRAUN, Consp. syst. Charac. europ., 1867, p. 6; id. in Monatsber. Kön. Akad. Wiss. Berlin f. 1867, p. 800, 1868; id. in COHN, Krypt. Fl. Schles. 1, 1849, p. 408; BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 22; T. F. ALLEN, Charac. America 1, 1888, p. 60; HY in Bull. Soc. bot. France 60, 1913, Mém. 26, p. 38; NORDSTEDT in Proc. Roy. Soc. Vict. 31, N.S., 1918, p. 6; GROVES & BULLOCK WEBSTER, Brit. Charoph. 2, 1924, p. 50; J. GROVES in Journ. Linn. Soc., Bot., 46, 1924, p. 363; PRINTZ in ENGLER & PRANTL, Nat. Pfl. fam. 3, ed. 2, 1927, p. 429; GROVES & ALLEN in Proc. Roy. Soc. Queensl. 46, 1935, p. 58; ZANEVELD in Blumea 3, 1939, p. 381 — *Chara* subsect. *Corticatae triplostichae* A. BRAUN in N. Denkschr. Schweiz. Ges. Naturw. 10, 1849, p. 19; id. in HOOKER's Journ. Bot. 1, 1849, p. 203; id., id., 298; VON LEONHARDI in Verh. naturf. Ver. Brünn 2, 1864, repr. p. 43 (*nom. tant.*).

Rows of cortical-cells of the stem thrice as numerous as the branchlets; between two successive primary rows two rows of secondary cells are produced.

Key to the series.

1a. All articulations of the branchlets ecorticate . . . . 1. GYMNOCLADIA
b. Lowest articulation of the branchlets corticate . . . 2. PHLOEOBASALIA
c. Lowest articulation of the branchlets ecorticate . . . 3. GYMNOBASALIA

1. Series GYMNOCLADIA ZANEV., nov. ser.

Ramulorum articulationes omnino ecorticatae.

All articulations of the branchlets destitute of cortical-cells.

Remarks. The species with this character are at present, as far as I know, only two in number, viz. *Chara Handae* and *C. guatemalensis*.

17. Chara Handae PAL in Journ. Linn. Soc. Bot. 49, 1932, p. 86, pl. 18.

Plant monoecious. *Stem* moderately stout. *Internodes* as long as or somewhat shorter than the branchlets. *Stem-cortex* triplostichous, cells of the primary series more prominent than those of the secondary one. *Spine-cells* well developed, solitary, acute, as long as the diam. of the stem. *Stipulodes* in a double whorl, acute, those of the upper whorl slightly better developed. *Branchlets* 9—11 in a whorl, incurved, composed of 5 ecorticate articulations. *Bract-cells* 4—8, well developed, except at the ultimate node, slender, acute. *Bracteoles* 1½ times the length of the oogonium. ♂ and ♀ *gametangia* together at the three lowest nodes, solitary. *Antheridia* 350 μ in diam. *Oogonia* 875 μ long (incl. coronula), 615 μ wide; *spiral-cells* showing 15—16 convolutions; *coronula* 105 μ high, 190 μ wide at base, individual cells straight; *oospores* black, 615 μ long, 400 μ wide, with 11—13 ridges, terminating in short basal claws.

Remarks. This species is distinguished from all hitherto known *Triplostichae* by the entirely ecorticate branchlets. As I did not see a specimen I gave an abstract from the type description.

Ecology. *Chara Handae* has a bushy appearance due to the short internodes and the long branchlets. PAL cites that it was found growing together with *Chara burmanica*, *C. Grovesii* and *C. brachypus*. The species was collected in a stream, and may be found from September to the middle of November.

Distribution. 22° N.; ASIA, India: Burma.

2. Series PHLOEOBASALIA ZANEV., nov. nom. — *Phloeopodes*[1]) A. BRAUN in HOOKER's Journ. Bot. 1, 1849, p. 203; id., ibid., p. 298; id. in Monatsber. Kön. Akad. Wiss. Berlin f. 1867, p. 800, 1868; BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 22; T. F. ALLEN, Charac. America 1, 1888, p. 60; NORDSTEDT in Proc. Roy. Soc. Vict. 31, N. S., 1918, p. 6; J. GROVES in Journ. Linn. Soc., Bot., 46, 1924, p. 374; PRINTZ in ENGLER & PRANTL, Nat. Pfl. fam. 3, ed. 2, 1927, p. 429; GROVES & ALLEN in Proc. Roy. Soc. Queensl. 46, 1935, p. 58; ZANEVELD in Blumea 3, 1939, p. 381.

[1]) Also spelt as "*Phlacopodes*" by BRAUN.

Lowest articulation of the branchlets provided with cortical-cells.

Remarks. As was already pointed out the third series has to be renamed. Therefore BRAUN's name for the present series is substituted at the same time, as it would otherwise become a permanent source of confusion.

18. Chara aspera [1]) WILLDENOW in Mag. Ges. naturf. Freunde Berl. 3, 1809, p. 298; AGARDH, Syst. Alg., 1824, p. 130; BRUZELIUS & FUERNROHR in Flora 9, 1826, p. 490; BRAUN in Ann. Sci. Nat. Sér. 2, 1834, p. 356, *pro parte*; id. in Flora 18, 1835, p. 71, excl. var.; KUETZING, Phyc. Germ., 1845, p. 257; BRAUN in N. Denkschr. Schw. Ges. Naturw. 10, 1849, p. 20; KUETZING, Spec. Alg., 1849, p. 521; WALLMAN in Act. Soc. Linn. Bordeaux 21, 1856, p. 79; KUETZING, Tab. Phyc. 7, 1857, p. 21, pl. 51, f. 2 [2]), pl. 52; BRAUN, Consp. syst. Charac. europ., 1867, p. 6; id. in Monatsb. Kön. Akad. Wiss. Berlin f. 1867, p. 851, 1868; BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, pp. 22, 174; T. F. ALLEN, Americ. Charac. 1, 1888, p. 60 (*nom. tant.*); NORDSTEDT in Lunds Univ. Års-skr. 25, 1889, p. 37; GIESENHAGEN in Flora 82, 1896, p. 3, figs. 1—10; MIGULA, Die Charac., 1897, p. 653, figs. 134—135; id., Syn. Charac. europ., 1898, p. 140, figs. 119—120; ROBINSON in Bull. New York Bot. Gard. 4, 1906, p. 281; STROEDE, Oekol. Charac. 1931, p. 38, pl. 2, f. 7; G. O. ALLEN in Journ. Ind. Bot. Soc. 12, 1933, p. 17, pl. 1; VERDAM in Blumea 3, 1938, p. 26 — *Chara pulchella* WILLD. var. *aspera* WILLDENOW in WALLROTH, Flor. Crypt. German. 1833, p. 109 — *Chara aspera* WILLD. var. *Macounii* T. F. ALLEN in Bull. Torrey Bot. Cl. 9, 1882, p. 44, pl. 21 — *Chara Macounii* (T. F. ALLEN) ROBINSON in Bull. New York Bot. Gard. 4, 1906, p. 281.

Plant dioecious. *Stem* slender, up to 500 μ in diam. *Internodes* 2—3 times the length of the branchlets. Whitish spherical *bulbils* present at the root-nodes, solitary or in clusters of 2—6. *Stem-cortex* triplostichous, cells of the primary series larger than those of the secondary ones. *Spine-cells* solitary or sometimes 2—3 together, slender, acute, often with a bulbous base, up to 2½ times as long as the stem-diam. *Stipulodes* in a double whorl, both whorls usually equally developed; the cells of the upper whorl are sometimes as long as the lowest branchlet-articulation. *Branchlets* 8—9 in a whorl, straight or slightly incurved, composed of 6—8 articulations, of which the ultimate 1 or 2 are ecorticate and very acute, the other ones triplostichous. *Bract-cells* usually 5, lateral and anterior ones almost always exceeding the oogonia in length, posterior ones usually shorter than the oogonium. *Bracteoles* and *bractlet* somewhat longer than the anterior bract-cells. ♂ and ♀ *gametangia* solitary, at the four lowest nodes. *Antheridia* 400—600 μ in diam. *Oogonia* 600—800 μ long (excl. coronula), 400—550 μ wide; *spiral-cells* showing 13—15 convolutions; *coronula* 75—100 μ

[1]) An extensive list of the European literature, the synonyms and the figures are to be found in MIGULA (1897, pp. 653—654), GROVES & BULLOCK WEBSTER (1924, p. 51).

[2]) The piece of the stem in fig. f has a haplostichous cortex instead of a triplostichous one.

high, 120—200 μ wide at base; *oospores* black, 400—650 μ long, 250—400 μ wide, with 12—14 ridges, terminating in small basal claws.

Remarks. ALLEN (1933, p. 19) states that the specimens collected by him in India differs from the European plants by having small roundish spine-cells instead of long spines. *C. aspera* is at once characterized by having spherical whitish bulbils at the lower nodes, which do not occur in any other dioecious triplostichous *Chara* from Malaysia. These, *C. infirma* and *C. connivens* have both rudimentary spine-cells. No Malaysian plants seen.

Ecology. *Chara aspera* is a slender plant, usually occurring in lakes and large pools. There is a correlation between its being incrusted with lime, the presence of long spine-cells and a stout appearance.

In Germany it is found growing in anorganotrophic water with a pH of 7.42—8.06. The water in which it occurs may also have a high content of Cl, though it is often found in fresh water too. STROEDE (1931, p. 49) remarks that the Cl-content may vary from 16 to 3535 mg per l.

Chara baltica and *C. contraria* were collected in the same localities. STROEDE records as inhabitants of the same water in the island of Rügen: *Potamogeton pectinatus, Ulva lactuca, Enteromorpha intestinalis, Fucus vesiculosus*, etc. Though *C. aspera* usually occurs at a depth of 0.5—3 m, it is sometimes collected in much deeper water.

ALLEN (1933, p. 19) found it in India from February to the end of March.

Distribution. Between 70° N. and 25° N.; EUROPE, cf. BRAUN & NORDSTEDT (1882, p. 174); MIGULA (1897, p. 660); GROVES & BULLOCK WEBSTER (1924, p. 52) — ASIA, India: Gangetic Plain, ALLEN (1933, p. 17); Turkestan, ex GROVES & BULLOCK WEBSTER (1924, p. 53) — AMERICA, N. Am.: Canada, Saskatchewan, T. F. ALLEN (1882, p. 44); ROBINSON (1906, p. 282); New Foundland; United States, BRAUN & NORDSTEDT (1882, p. 175), ROBINSON (1906, p. 282) — AFRICA, N. Afr.: Algeria, BRAUN (1868, p. 852).

19. Chara infirma A. BRAUN in Abh. Kön. Akad. Wiss. Berlin, 1882, pp. 22, 177, pl. 7, figs. 264—266; id. in herb. HOOKER 1862 (*nom. tant.*); T. F. ALLEN, Amer. Charac. 1, 1888, p. 60 (*nom. tant.*); GROVES in Journ. Linn. Soc., Bot., 46, 1924, pp. 363, 374.

Plant dioecious, incrusted, not known to produce bulbils. *Stem* slender, 480—540 μ in diam. *Stem-cortex* triplostichous, cells of the primary and secondary series usually equal developed. *Spine-cells* very minute, up to 60 μ long. *Stipulodes* in a double whorl, strongly developed, those of the upper whorl somewhat longer. *Branchlets* 7—10 in a whorl, slightly spreading, composed of 6—7 articulations of which the ultimate 1—2 are ecorticate, the other ones triplostichous. *Bract-cells* 7—8, rigid, acuminate, the anterior ones well developed, 2—2½ times the length of the immature oogonium, the posterior 2—3 rudimentary. *Bracteoles* similar to but shorter than the anterior bract-cells. ♂ and ♀ *gametangia* at the four lowest branchlet-nodes, solitary. *Antheridium* 500—600 μ in diam. *Immature oogonium* 540—620 μ long, 420—480 μ wide. *Oospore* probably light-brown.

Remarks. BRAUN described this species as "dubia", since no mature female plants and no root parts were collected. Afterwards it is recorded only once, viz. by GROVES (*l.c.* p. 374), who could not detect ripe oogonia either. It is separable from the other dioecious triplostichous species by having strongly

developed stipulodes together with rudimentary spine-cells. Not having seen a specimen, I extracted the type description.

Ecology. GROVES (*l.c.*, p. 375) states that the species occurs in India at an elevation of 300—1800 m.

Distribution. Between 38° N. and 27° N.; ASIA, Persia, Afghanistan, BRAUN & NORDSTEDT (1882, p. 179); India: West Himalaya, India Deserta, GROVES (1924, p. 375).

20. Chara connivens[1]) SALZMANN ex A. BRAUN in Flora 18, 1835, p. 73; KUETZING, Spec. Alg., 1847, p. 521; WALLMAN in Act. Soc. Linn. Bordeaux 21, 1856, p. 82; KUETZING, Tab. Phyc. 7, 1857, p. 26, pl. 63, f. 1; BRAUN in SCHWEINFURT, Beitr. z. Flor. Aethiop., 1867, p. 180; id., Consp. syst. Charac. europ., 1867, p. 7; id., in Monatsber. Kön. Akad. Wiss. Berlin f. 1867, p. 855, 1868; BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, pp. 23, 180; T. F. ALLEN, Americ. Charac. 1, 1888, p. 62 (*nom. tant.*); MIGULA, Die Charac., 1897, p. 703, figs. 142—143; id., Syn. Charac. europ., 1898, p. 152, figs. 127—128; GROVES & BULLOCK WEBSTER, Brit. Charoph. 2, 1924, p. 57, pl. 41; FILARSZKY in Math. u. Naturwiss. Anz. d. Ungar. Akad. Wiss., 55, 1937, pp. 482, 484; VERDAM in Blumea 3, 1938, p. 29; HASSLOW in Botan. Not. Lund, 1939, p. 299.

Plant dioecious, bright-green, very brittle though not much incrusted, glossy. *Bulbils* not observed. *Stem* slender, rigid. *Stem-cortex* triplostichous, cells of the primary and secondary series of equal prominence. *Spine-cells* rudimentary. *Stipulodes* in a double whorl, rudimentary. *Branchlets* 6—10 in a whorl, rigid, especially in the male plant strongly incurved, consisting of 6—13 articulations of which the upper 1—2 are ecorticate, the other ones triplostichous. *Bract-cells* c. 7, hardly developed, at sterile nodes 1—3, anterior ones papilliform; at fertile nodes of female plants 3—5, anterior ones elongated though much shorter than the oogonium; at fertile nodes of male plants 2. *Bracteoles* and *bractlet* similar to the anterior bract-cells. ♂ and ♀ *gametangia* solitary, at the 3—4 lowest nodes. *Antheridia* 800—1100 μ in diam. (in the var. *pygmaea* 500—600 μ). *Oogonia* 850—1150 μ long (incl. coronula), 320—550 μ wide, *spiral-cells* showing 13—14 convolutions; *coronula* c. 200 μ high, c. 185 μ wide at base, individual cells strongly connivent; *oospores* black, 580—700 μ long, 240—350 μ wide, showing 12—13 faint ridges, terminating into inconspicuous basal claws (in var. *pygmaea* the sizes are, according to BRAUN [1868, p. 858]: *oogonium* 780—800 μ long, 360—380 μ wide; *coronula* 140—150 μ high; *oospores* 480—520 μ long, 240—260 μ wide).

Remarks. *Chara connivens* is one of the two dioecious members of the *Triplostichae* having reduced stipulodes, spine-cells, and branchlets. From *C. fragifera*, from Europe and Africa, it is distinguished by its more robust stem, the markedly connivent branchlets, the fewer number of branchlet-articulations, the long conical coronula, and especially by the lack of whitish bulbils at the lower stem- and root-nodes. I did not see an Indian specimen.

Ecology. This slender species prefers in Europe and Africa brackish

---

[1]) Only some of the principal European papers are cited here, for further literature cf. MIGULA (1897, p. 703) and GROVES & BULLOCK WEBSTER (1924, p. 57).

waters, though it may also be found in fresh water. It has been found growing together with *Chara Braunii* and *C. globularis*. In Africa it is found from March to July and the only record from India is dated April.

Distribution. Between 55° N. and 25° N.; EUROPE, cf. BRAUN & NORDSTEDT (1882, p. 180), MIGULA (1897, p. 708), GROVES & BULLOCK WEBSTER (1924, p. 58) — ASIA, Palestine, ex GROVES & BULLOCK WEBSTER (1924, p. 58); India: Gangetic Plain, FILARSZKY (1937, p. 484) — AFRICA, N. Afr.: Algeria, Tunisia, Egypt, BRAUN (1868, p. 857).

21. Chara globularis [1]) THUILLER, Flor. Env. Paris, ed. 2, 1799, p. 472; PERSOON, Syn. Plant., 2, 1807, p. 530 — *Chara Hedwigii* AGARDH apud BRUZELIUS, Observ. Charac., 1824, pp. 7, 21; AGARDH, Syst. Alg., 1824, p. 129; BRUZELIUS & FUERNROHR in Flora 9, 1826, p. 489; CHEVALLIER, Flor. Génér. Env. Paris, 1827, p. 126, *pro parte*; KUETZING, Tab. Phyc. 7, 1857, p. 23 — *Chara pulchella* WALLROTH *β globularis* THUILL., WALLROTH, Flor. Crypt. Germ., 1883, p. 108 — *Chara fragilis* DESVAUX, A. BRAUN in Flora 18, 1835, p. 68, *pro parte*; id., in Ann. Sci. Nat. Bordeaux, sér. 2, 1834, p. 356; KUETZING, Phyc. germ., 1845, p. 257, *pro parte*; id., Spec. Alg., 1849, p. 521, *pro parte*; RUPRECHT, Beitr. Pflanz. Russ. Reich. 1, 1844, p. 16; BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin 1882, pp. 23, 181, *pro parte*; H. & J. GROVES in Journ. Linn. Soc., Bot., 37, 1906, p. 286 — *Chara fragilis* DESV. var. *elongata* KUETZING, Spec. Alg., 1849, p. 521 — *Chara fragilis* DESV. var. *Hedwigii* (AGARDH) WALLMAN in Act. Soc. Linn. Bordeaux 21, 1856, p. 84; KUETZING, Phyc. Gen., 1843, p. 319; A. BRAUN, Consp. syst. Charac. europ. 1867, p. 7; GROVES & BULLOCK WEBSTER, Brit. Charoph. 2, 1924, p. 64 — *Chara fragilis* DESV. var. *major-longifolia* A. BRAUN, HALSTED in Proc. Boston Soc. Nat. Hist. 19, 1879, p. 188 — *Chara fragilis* DESV. f. *Hedwigii* (AGARDH) MIGULA, Die Charac., 1897, p. 730; id., Syn. Charac. europ., 1898, p. 158; VERDAM in Blumea 3, 1938, p. 32 — *Chara capillacea*; *C. fragilis* ssp. et var. *capillacea*, ssp. *fragilis* var. *pulchella*; var. *subverrucosa*, var. *subverrucosa* f. *platensis*; *C. hirta*; *C. pulchella*; *C. viridis*; cf. var. *capillacea*.

Illustrations. KUETZING, Tab. Phyc. 7, 1857, pl. 55, f. 1; GROVES & BULLOCK WEBSTER, Brit. Charoph. 2, 1924, pl. 43.

Plant monoecious, dull green, up to 60 cm high (MIGULA collected plants in Germany of 1 m in length [1897, p. 730]). *Stem* stout, 1000—1400 μ in diam. *Internodes* 1½—2 times the length of the

---

[1]) MIGULA (1897, pp. 722—723) and GROVES & BULLOCK WEBSTER (1924, pp. 61—62, 64—65) cite more synonyms, figures and European literature.

branchlets. Irregular multicellular *bulbils* sometimes present. *Cortex* triplostichous, cells of primary and secondary series of equal width. *Spine-cells* extremely small, only visible in very young internodes. *Stipulodes* in a double whorl, greatly reduced and inconspicuous. *Branchlets* 7—8 in a whorl, straight, very long, up to 6 cm, consisting of 8—10 articulations of which the upper 1—3 are ecorticate, cortical-cells on branchlets twice as numerous as the bract-cells. *Bract-cells* c. 7, varying in length, equal or somewhat shorter than the oogonium, only one anterior pair developed, posterior cells rudimentary at fertile nodes, at sterile nodes frequently wanting. *Bracteoles* sometimes developed, shorter or as long as the oogonium. ♂ and ♀ *gametangia* solitary, at the 3—4 lowest branchlet-nodes. *Antheridia* 300—500 μ in diam. *Oogonia* 800—1100 μ long (incl. coronula), 500—700 μ wide; *spiral-cells* showing 14—17 convolutions; *coronula* 175—250 μ high, 200—375 μ wide at base, individual cells erect and connivent, usually truncate at the apex; *oospores* black, 500—700 μ long, 350—450 μ wide, with 12—15 well pronounced ridges prolonged downwards into a cage.

Remarks. The present species was hitherto known as *Chara fragilis* DESV., though more than one author has remarked that this name had to be substituted. Moreover, BRAUN knew that *C. globularis* was identic with *C. Hedwigii* and considered the latter a form of DESVAUX' *C. fragilis*. The same author states (1876, p. 395, note 1), that THUILLER's *C. globularis* was established on specimens of *C. fragilis* with a colourless oospore membrane. The oospore is globular and looks white, containing a considerable quantity of starch. BRAUN supposes that this is due to non-fertilization, as the same process can be found in almost every species. This, however, is not a reason to neglect the name of THUILLER and to use the later one of DESVAUX.

At the Rijksherbarium at Leiden there are five specimens extant in the herbarium of PERSOON, two of these being labelled by himself as follows: 1. "*Chara capillaris* THUILL."; 2. "*Chara viridis, Chara capillaris* TH., prope Parisios". On the labels of the other three specimens PERSOON himself has only written: "THUILLER". Above this word stands the name of the plant written in another script, which I could not identify with one of the handwritings from the collection extant in the Rijksherbarium. Label 3 bears the name: "*Chara capillacea*", label 4: "*Chara funicularis*" and label 5: "*Chara globularis*". Most probably this handwriting hails from THUILLER himself, but as there was no original handwriting from him in the collection I could

not state this with certainty. According to LÜTJEHARMS (1938, p. 42), PERSOON lived at Paris from 1800—1836, and as he was perfectly well connected with contemporary colleagues, it is probable that the plants were determined by THUILLER.

Afterwards all these plants were seen by BRAUN who determined them as follows: 1. "*Chara fragilis* DESV. forma *tenuifolia* (*Ch. capillacea* THUILL.)"; 2 and 3: "*Chara fragilis* DESV."; 4. "*Chara fragilis* var. *Hedwigii* (*Ch. globularis* THUILL. non *Ch. funicularis* THUILL.)"; 5: "*Chara fragilis* DESV. var. *Hedwigii*, semin. degeneratis (*Ch. globularis* THUILL.)".

Especially BRAUN's remark on sheet 5 "semin. degeneratis" led me to the conclusion that this must be the type or a cotype. As I identified the specimens on sheets 4 and 5 as *C. globularis* var. *Hedwigii* (no root parts are preserved) there is no doubt that THUILLLER's name is valid and must be accepted.

The plants with a much smaller habit, more slender stem, shorter internodes and branchlets are now considered a variety for which the name *capillacea* THUILLLER (non WALLMAN) has to be used. To this variety belong the Indian plants to be described below.

Chara globularis can only be confused with *C. brachypus*, another monoecious member of the *Triplostichae* which has, however, well developed stipulodes, and a branchlet-cortex with cells about three times as numerous as the bract-cells. *C. zeylanica* has the lowest branchlet-articulation ecorticate. For reasons pointed out under the remarks of var. *capillacea* I mention the ecology here.

Ecology. *Chara globularis* is a cosmopolitan species, dull to greyish-green according to its being more or less incrusted, and varying in height from c. 25 cm up to 1 m. These larger forms are the typical ones (var. *Hedwigii*), whereas the plants of var. *capillacea* are more tiny. As the plants are usually brittle, the dried specimens are often broken up.

The species occurs in fresh water, not in tufts as *C. delicatula* does, but some collectors found it in brackish water. STROEDE records it from Rügen from water with 3332 mg Cl per l. This water may be anorganotrophic or organotrophic, though the latter is preferred. As to the pH, STROEDE found that the optimum range is 7—7.8. *C. globularis* is able to withstand a considerable range in temperature as it is known from the hot springs in Iceland, "the temperature of the spring in which this plant was growing was such as to boil an egg in four minutes" (cf. BRAUN & NORDSTEDT, 1882, p. 182), and in "Yellowstone Park, in Geyser springs, temperature 100° F." (T. F.

ALLEN, 1882, p. 46), whereas T. F. ALLEN records it also "in ice water at the north".

Specimens of the var. *capillacea* have been found in stagnant water of little and large water-basins, in lowland country and mountainous areas, i.e. 1050 m in Flims (Switzerland, BRAUN, 1849, p. 22), whereas the typical forms prefer somewhat running water. It usually occurs at no greater depth than 1 m.

On account of its being eurytrophic *C. globularis* has often been found growing together with a number of other *Charophyta*. Higher aquatic plants growing in the same locality are in Europe: *Phragmites communis, Typha angustifolia, Scirpus lacustris, Butomus umbellatus, Nymphaea alba, Nuphar luteum, Myriophyllum spicatum, Potamogeton pectinatus*; in Malaysia: *Ceratophyllum demersum, Potamogeton crispus, P. pectinatus, Myriophyllum verticillatum* (MUKERJI, 1932, p. 328).

Ripe oospores are found in Germany from June to September (STROEDE, 1931, p. 31), in India from November to May (ALLEN, 1928, p. 66).

With regard to the light-intensity MUKERJI (1932, p. 328) states, that it shows a great tolerance towards very low intensities of light, being also fully capable of growing in very bright light. The same author states that in Dal Lake, *C. globularis* is found up to a depth of 6 m, whereas in Manasbal Lake, in which the water is six to eight times clearer than in Dal, *C. globularis* extends further down to a depth of about 7.5 m.

Distribution[1]). Between 70° N. and 50° S.; ASIA, India; Indo-China; cf. var. *capillacea*. Moreover in lit.: EUROPE, cf. BRAUN & NORDSTEDT (1882, pp. 181—182), MIGULA (1897, p. 728), GROVES & BULLOCK WEBSTER (1924, pp. 63—64) — ASIA: Siberia, Kamchatka, BRAUN & NORDSTEDT (1882, p. 38); NORDSTEDT (1889, p. 38); Songaria, RUPRECHT (1884, p. 16); Altai, BRAUN & NORDSTEDT (1882, p. 182); Japan, ALLEN (1894, p. 523); India: West Himalaya, GROVES (1924, p. 375), MUKERJI (1932, p. 328; 1934, p. 295); Malabaria, GROVES (1924, p. 375), DIXIT (1935, p. 261); Gangetic Plain, GROVES (1924, p. 375), ALLEN (1925, p. 597), GROVES & ALLEN (1927, p. 339), ALLEN (1928, p. 64; 1933, p. 17; 1936, p. 51); Bengal, BRAUN & NORDSTEDT (1882, p. 182), AGHARKAR & KUNDU (1937, p. 17); Malaysia, Lombok (Segara Anak), VAN DER VEEN (1937,

[1]) Including the distribution of the var. *capillacea*.

p. 198 [1]) — AMERICA, N. Am.: Canada, BRAUN & NORDSTEDT (1882, p. 183), NORDSTEDT (1889, p. 38), ROBINSON (1906, p. 279); New Foundland; United States, BRAUN & NORDSTEDT (1882, p. 183); C. Am.: Mexico, BRAUN & NORDSTEDT (1882, p. 183), ROBINSON (1906, p. 279); S. Am.: Peru, BRAUN & NORDSTEDT (1882, p. 183), Uruguay, BRAUN & NORDSTEDT (1882, p. 866); Spegazzini (1883, p. 229), ALLEN & HERTER (1934, p. 91) — AFRICA, N. Afr.: Algeria, NORDSTEDT (1889, p. 38); Egypt, Canary Islands, BRAUN (1868, p. 866); S. Afr.: Cape Colony, BRAUN (1868, p. 866), GROVES (1906, p. 286); Madagascar, GROVES (1928, p. 135), ZANEVELD (1939, p. 382) — AUSTRALIA, W. Austr.: Darebin Creek (?), BRAUN & NORDSTEDT (1882, p. 183); Moores River, Nepean River, Port Philip, NORDSTEDT (1889, p. 38); S. Austr., Torrens River, BRAUN & NORDSTEDT (1882, p. 182); Queensland, NORDSTEDT (1889, p. 192), BAILEY (1909, p. 682), GROVES & ALLEN (1935, p. 58); N. S. Wales, HASSLOW (1939, p. 301); Victoria, NORDSTEDT (1889, p. 192); Tasmania, BRAUN & NORDSTEDT (1882, p. 183), NORDSTEDT (1889, p. 38); New Zealand, NORDSTEDT (1880, p. 20; 1888, p. 192), BRAUN & NORDSTEDT (1882, p. 39).

var. α **capillacea** (THUILLER) ZANEV., nov. comb. — *Chara vulgaris* L., Spec. Plant., 1753, p. 1156, *pro parte* — *Chara capillacea* THUILLER (non WALLMAN), Flor. Env. Paris, 1799, p. 174; PERSOON, Syn. Plant., 1807, p. 530; CHEVALLIER, Flor. gén. env. Paris, 1827, p. 126; KUETZING, Tab. Phyc. 7, 1857, p. 23 — *Chara fragilis* DESVAUX apud LOISELEUR, Not. Pl. aj. Flor. France, 1810, p. 137; A. BRAUN in Ann. Sci. Nat. Bot. sér. 2, 1834, p. 356, *pro parte*; id. in Flora 18, 1835, p. 68, *pro parte*; KUETZING, Phyc. gen., 1843, p. 319, *pro parte*; id., Phyc. germ., 1845, p. 257, *pro parte*; id., Spec. Alg., 1849, p. 521, *pro parte*; A. BRAUN in N. Denkschr. Schw. Ges. Naturw. 10, 1849, p. 21; id. in Linnaea 25, 1852, p. 709; id. in HOOKER's Flor. Tasman. 3, 1860, p. 160; id., Consp. syst. Charac. Europ., 1867, p. 7; id. in Monatsber. Kön. Akad. Wiss. Berlin f. 1867, p. 866, 1868; id. in COHN's Krypt. Flor. Schles. 1, 1876, p. 410; HALSTED in Proc. Boston Soc. Nat. Hist., 1879, p. 188; NORDSTEDT in Lunds Univers. Års-skr. 16, 1880, p. 20; T. F. ALLEN in Torrey Bot. Cl. 9, 1882, p. 45; BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, pp. 23, 182, *pro parte*; T. F. ALLEN, Charac. Americ. 1, 1888, p. 62 (*nom. tant.*); NORDSTEDT in Lunds Uni-

[1]) It should be added that I have not seen this specimen and as it is probably not preserved, the occurrence of this species in the Netherlands Indies is not certain.

vers. Års-skr. 25, 1889, p. 38; T. F. Allen in Bull. Torrey Bot. Cl. 21, 1894, p. 523; Migula, Die Charac., 1897, p. 722; id., Synops. Charac. europ., 1898, p. 158; Robinson in Bull. New York Bot. Gard. 4, 1906, p. 279; Bailey, Compreh. Cat. Queensl. Pl., 1909, p. 682; J. Groves in Journ. Linn. Soc., Bot., 46, 1924, pp. 363, 375; G. O. Allen in Journ. Bomb. Nat. Hist. Soc. 30, 1925, p. 597; Groves & Allen in Journ. Bot., 1927, p. 339; G. O. Allen in Journ. Ind. Bot. Soc. 7, 1928, p. 64; J. Groves in Journ. Linn. Soc., Bot., 48, 1928, p. 135; Stroede, Oekol. Charac., 1931, p. 31; Mukerji in Proc. 19th Ind. Sci. Congr., Bangalore, 1932, p. 328; id. in Proc. 21th Ind. Bot. Congr., Bombay, 1934, p. 295; G. O. Allen in Journ. Ind. Bot. Soc. 12, 1933, p. 17; Dixit, in Journ. Ind. Bot. Soc. 14, 1935, p. 261; Groves & Allen in Proc. Roy. Soc. Queensl. 46, 1935, p. 58; G. O. Allen in Journ. Ind. Bot. Soc. 15, 1936, p. 51; Agharkar & Kundu in Journ. Dep. Sci., N. S. 1, 1937, p. 17; Verdam in Blumea 3, 1938, p. 31; Zaneveld in Blumea 3, 1939, pp. 381—382; Hasslow in Bot. Not. Lund, 1939, pp. 298, 301 — *Chara pulchella* Wallroth, Annus Bot., 1815, p. 184; id., emend. Flor. Crypt. Germ., 1833, p. 108; Agardh, Syst. Alg., 1824, p. 129 — *Chara hirta* Meyen in Linnaea 2, 1827, p. 78 — *Chara fragilis* Desv. ap. Lois. ssp. *capillacea* (Thuill.) Wallman in Act. Soc. Linn. Bordeaux 21, 1856, p. 85 — *Chara gracilis* Spr. var. *capillacea* (Thuill.) Wallroth, Flor. Crypt. Germ., 1883, p. 109 — *Chara fragilis* Desv. ap. Lois. ssp. *fragilis* Desv. var. *pulchella* (Wallr.) Wallman in Act. Soc. Linn. Bordeaux 21, 1856, p. 84 — *Chara viridis* Hartman, Handb. Skand. Flor., ed. 1, 1820, p. 376 — *Chara fragilis* Desv. ap. Lois. *β subverrucosa* A. Br. in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 182 — *Chara fragilis* Desv. ap. Lois. *β subverrucosa* A. Br. f. *platensis* Spegazzini in Anal. Soc. Cient. Agent. 15, 1883, p. 229; Allen & Herter in Revist. Sudamer. Bot. 1, 1934, p. 91.

Illustrations. Kuetzing, Tab. Phyc. 7, 1857, pl. 54, pl. 55, f. 2; T. F. Allen in Bull. Torr. Bot. Cl. 9, 1882, pl. 22; Migula, Die Charac., 1897, figs. 146, 147; id., Syn. Charac. europ., 1898, figs. 131, 132; G. O. Allen in Journ. Ind. Bot. Soc. 7, 1928, pl. 1; Agharkar & Kundu in Journ. Dep. Sci., N. S. 1, 1937, pl. 8, figs. 4—6, pl. 9, f. 1.

Plant small, slender, and more tiny than the typical var. *Hedwigii*, slightly incrusted. *Stem* rather slender, c. 750 μ in diam., very brittle. *Internodes* nearly as long as the branchlets. *Branchlets* 4—30 mm long, usually a little incurved at their base. ♂ and ♀ *gametangia* usually at the three lowest nodes, rarely at the fourth.

India: "India orientalis", without exact locality and date, Griffith

s.n. (B); Gangetic Plain, Behar, no date and collector's name, ex herb. HOOKER 1858 (B); Bengal, without exact locality, date and collector's name, ex herb. HOOKER 1853 (B).

INDO-CHINA: W. Tonkin, without exact locality and date, BON 2435 (P).

Remarks. As both the varieties *Hedwigii* and *capillacea* have been generally combined, the distribution and the ecology of both is cited on pp. 194, 195. However, most probably var. *Hedwigii* is restricted to the Northern Temperate zone.

Distribution. Between 25° N. and 20° N.; ASIA, India; Indo-China.

22. Chara delicatula [1]) AGARDH em. A. BRAUN, Syst. Alg. 1824, p. 130 (non *C. delicatula* DESVAUX); BRAUN in COHN's Krypt. Flor. Schles. 1, 1876, p. 411; MIGULA, Die Charac., 1897, pp. 752, f. 148; id. Syn. Charac. europ., 1898, p. 164, f. 133; ROBINSON in Bull. New York Bot. Gard. 4, 1906, p. 280; KUCZEWSKI in Beih. Bot. Centralbl. 20, 1906, p. 25; GROVES & BULLOCK WEBSTER, Brit. Charoph. 2, 1924, pp. 65—69, pl. 44; G. O. ALLEN in Journ. Ind. Bot. Soc. 7, 1928, p. 64 — *Chara pulchella* WALLR. var. *delicatula* WALLROTH, Flor. Crypt. Germ., 1833, p. 108 — *Chara virgata* KUETZING, in Flora 17, 1834, p. 705; id., Tab. Phyc. 7, 1857, p. 23, pl. 56, f. 2 — *Chara fragilis* DESV. ap. LOIS. var. *longibracteata* RABENHORST, Deutschl. Krypt. Fl. 2, 1847, p. 200; A. BRAUN in N. Denkschr. Schweiz. Ges. Naturw. 10, 1849, p. 21 — *Chara verrucosa* ITZIGSOHN in Bot. Zeit., 1850, p. 338; ROBINSON in Bull. New York Bot. Gard. 4, 1906, p. 280; VERDAM in Blumea 3, 1939, p. 33 — *Chara fragilis* DESV. ap. LOIS. var. *delicatula* VON LEONHARDI in Verh. Naturf. Verein. Brünn 2, 1864, p. 209; A. BRAUN, Consp. syst. Charac. europ., 1867, p. 7; HASSLOW in Bot. Not. Lund, 1939, p. 298 — *Chara fragilis* DESV. ap. LOIS. ssp. *delicatula* A. BRAUN in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 184, pl. 7, figs. 269—270; T. F. ALLEN, Charac. Americ. 1, 1888, p. 62.

Plant monoecious, up to 15 cm long, sometimes incrusted. *Stem* slender, 375—500 μ in diam. *Internodes* as long as to twice as long as the branchlets. *Stem-cortex* triplostichous, primary cortical-cells more developed than the secondary ones. *Spine-cells* developed, usually very minute. *Stipulodes* in a double whorl, well developed, those of the upper whorl sometimes much longer than those of the rudimentary lower whorl. *Branchlets* 7—8 in a whorl, composed of 8—11 articulations of which the upper 1—3 are ecorticate, the other ones diplostichous. *Bract-cells* 5—7, posterior ones not developed, anterior ones ½—1 times the length of the oogonium. *Bracteoles* somewhat longer than the oogonium. ♂ and ♀ *gametangia* together at the three lowest branchlet-nodes, solitary. *Antheridia* 350—560 μ in diam. *Oogonia* 850—1200 μ long (incl. coronula), 500—700 μ wide; *spiral-cells* showing 14—15 convolutions; *coronula* 100—240 μ high, 180—260 μ wide at base, individual cells connivent, oblong-lanceolate; *oospores* black, 625—720 μ long, 340—550 μ wide with 12—14 ridges, terminating in basal claws.

---

[1]) Only the principal synonyms and european literature are cited; more information is to be found in MIGULA (1897, p. 752) and in GROVES & BULLOCK WEBSTER (1924, pp. 65—66).

Remarks. This species closely resembles *C. globularis* from which it is distinguished by having the primary cortical-cells more developed, the stipulodes more elongated and the spine-cells very small. These characters, however, are variable, and therefore one may favour the view to regard *C. delicatula* as a subspecies of *C. globularis*. As I have only seen European material I will not give a decision at present. Though DESVAUX (1810, p. 137) was the first in using the name *delicatula*, he is not cited as an author because his specimen was a representative of *C. aspera* (according to BRAUN).

BRAUN distinguishes two series of plants, viz. *bulbilifera* with one-celled stem bulbils at the lower nodes, and *verrucosa*, without such bulbils. G. O. ALLEN (1928, p. 64) does not say to which series the plant from Benares belongs.

Ecology. *Chara delicatula* is usually a tiny plant, never growing as tall as *C. globularis*. It is found in the same ponds, pools, lakes and streams as the last-named species; in Great Britain it is especially common in the moorland districts.

Distribution. Between 70° N. and 50° S.; EUROPE, BRAUN & NORDSTEDT (1882, p. 184); MIGULA (1897, p. 755); GROVES & BULLOCK WEBSTER (1924, p. 67) — ASIA, Siberia, BRAUN & NORDSTEDT (1882, p. 184); Japan, ex GROVES & BULLOCK WEBSTER (1924, p. 67); India: BENARES, ALLEN (1924, p. 64) — AMERICA, N. Am.: Connecticut, California, BRAUN & NORDSTEDT (1882, p. 184); Alaska, Maine, New York, ROBINSON (1906, p. 280); Long Island, T. F. ALLEN (1882, p. 46) — AFRICA, S. Afr., ex GROVES & BULLOCK WEBSTER (1924, p. 67, without exact locality).

23. Chara inermis ZANEV., nov. spec.

Illustrations. The pres. paper, figs. 20*a*—*d*.

Planta monoica, fragilis, glaucescens, ad 25 cm alta. *Caulis* robusta, usque ad 1200 μ diam. *Internodia* ramulis ½—4-plo longiora. *Cortex* regulariter triplostichus; cellulis primariis et secundariis subaequaliter prominentibus. *Spinulae* deficientes. *Stipulodia* biseriata, ramulis duplex longiora acuta, stipulodia seriei superioris valde evoluta, 525 μ longa, 95 μ lata; seriei inferioris 315 μ longa, 60 μ lata. *Verticillorum ramuli* 7—10, triplostiche corticati, 8—9 articulationibus, segmento inferiori subdiaphano, supremis 1—3 ecorticatis. *Bracteae* 2 anteriores evolutae, posteriores rudimentariae. *Bracteoli* 225—450 μ longi, 105 μ lati. ♂ et ♀ *gametangia* solitaria, in omnibus nodis corticata. *Antheridia* 255—300 μ diam. *Oogonia* (coronula inclusa) 650 μ longa, 405 μ lata, strias 11—12; *coronula* 105 μ alta, basi 150 μ lata; *oosporae* nigrae, 450 μ longae, 365 μ latae, striis 9—10.

Plant monoecious, greyish green, not at all incrusted, brittle, probably taller than 25 cm. *Stem* robust, up to 1200 μ in diam. *Internodes* ½—4 times as long as the branchlets. *Cortex* regularly triplostichous, cells of the primary and secondary cortical series equally prominent, cortical node-cells extremely small. *Spine-cells* absent.

Stipulodes forming a double whorl, twice as numerous as the branchlets, acute, stipulodes of the upper whorl 525 μ long, 95 μ wide, shorter or as long as the lowest branchlet-internode, somewhat incurved, those of the lower whorl 315 μ long, 60 μ wide. *Branchlets* 7—10, consisting of 8—9 articulations, the lowest one triply corticated but subdiaphanous (without chlorophyll), the ultimate 1 or 2, (rarely 3) ribbon-shaped and, ecorticate, the other articulations triplostichous. *Bract-cells* 2, only the anterior present, small, 165—425 μ long, c. 75 μ wide, acute, the up to 4 papillae scarcely visible, bract-cells wanting at sterile nodes. *Bracteoles* similar to the bract-cells, 225—450 μ long, c. 105 μ wide. ♂ and ♀ *gametangia* solitary, at all corticated nodes, and at the same nodes. On account of the shortness of the first articulation, they seem to be situated at the base of the branchlets. *Antheridia* 255—300 μ in diam. *Oogonia* 650 μ long (incl. coronula), 405 μ wide; *spiral-cells* showing 11—12 convolutions; *coronula* 105 μ high, 150 μ wide at base, individual cells ovate, diverging at the apex; *oospores* black, 450 μ long, 365 μ wide, with 9—10 ridges.

SOEMBA: Nabeso, in a swamp, 27 III 1925, Soemba Expedition, IBOET 126, (L, *type*; Bz, cotype).

Remarks. This species is very closely allied to *Chara brachypus* and *C. pseudo-brachypus*, from both it is to be distinguished by the absence of spine-cells. Moreover, the habit of the plant is more robust than in the two species mentioned, though the ripe oospores are smaller. In a dried state the specimens have a rhomboid-like texture on the cortex. It differs from *C. globularis* by its triplostichously corticated branchlets, the very short lowest branchlet-articulation, very well developed stipulodes and smaller gametangia, from *C. infirma* by being monoecious and from *C. zeylanica* by the corticated, yet subdiaphanous lowest branchlet-articulation, and from all three mentioned *Triplostichae* by the absence of spine-cells even in the younger parts.

Ecology. The only ecologic informations at hand concerning this species are that it inhabits swamps, and that plants with ripe oospores have been found in March.

Distribution. 10° S.; ASIA, Malaysia: Soemba.

24. Chara brachypus A. BRAUN in HOOKER's Journ. Bot. 1, 1849, p. 298; KUETZING, Spec. Alg., 1849, p. 522; WALLMAN in Act. Soc. Linn. Bordeaux 21, 1856, p. 58; KUETZING, Tab. Phyc. 7, 1857, p. 24; A. BRAUN in SCHWEINFURTH, Beitr. z. Fl. Aethiop., 1867, p. 230; id., in Monatsb. Kön. Akad. Wiss. Berlin f. 1867, p. 939, 1868; BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, pp. 23, 185; T. F. ALLEN, Charac.

Amer. 1, 1888, p. 62 (*nom. tant.*); NORDSTEDT in Forsch. Reise S. M. S. "Gazelle", 4 Th., Bot. 1889, p. 8; DE WILDEMAN, Prodr. Flor. Alg. Ind. Néerl., 1897, p. 30; id., Suppl. et Tabl. Stat. 1899, p. 96; H. & J. GROVES in Philipp. Journ. Sci. Bot. 7, 1912, p. 70; J. GROVES in Journ. Linn. Soc., Bot., 46, 1924, pp. 363, 375; G. O. ALLEN in Journ. Bomb. Nat. Hist. Soc. 30, 1925, p. 597; J. GROVES in Journ. Linn. Soc., Bot., 48, 1927, p. 135; GROVES & ALLEN in Journ. Bot. 65, 1927, p. 339; G. O. ALLEN in Journ. Ind. Bot. Soc. 7, 1928, p. 65; DIXIT in Journ. Ind. Bot. Soc. 10, 1931, p. 206; PAL in Journ. Burma Res. Soc. 18, 1929, p. 113 (*nom. tant.*); id. in Journ. Linn. Soc., Bot., 49, 1932, p. 87; FILARSZKY in Arch. Hydrob. 1934, Suppl. Bd. 12, Trop. Binnengew. Bd. 4, p. 724; MUKERJI in Proc. 21st Ind. Sci. Cong., Bombay, 1934, p. 295; AGHARKAR & KUNDU in Journ. Dep. Sci., N. S. 1, 1937, p. 17 — ? *Chara setigera* KLEIN in herb. WILLDENOW 1796 (*cum descriptione*) — ? *Chara setosa* KLEIN ex WILLDENOW in Samml. d. Abh. Kön. Ak. Wiss. Berlin, 1806, p. 58; id. in Spec. Plant. 4, 1805, p. 184, *pro parte*; PERSOON, Synops. Plant., 1807, p. 530; AGARDH, Syst. Alg., 1824, p. 130; BRUZELIUS & FUERNROHR in Flora 9, 1826, p. 490 — *Chara brachypus* A. BR. *α setigera* KUETZING, Spec. Alg., 1849, p. 522 — *Chara brachypus* A. BR. *β nubica* KUETZING, Spec. Alg., 1849, p. 522; WALLMAN, Act. Soc. Linn. Bordeaux 21, 1856, p. 58.

Illustrations. WILLDENOW in Samml. d. Abh. Kön. Ak. Wiss. Berlin, 1806, pl. 1, f. 1; KUETZING, Tab. Phyc. 7, 1857, pl. 57, f. 2; G. O. ALLEN in Journ. Bomb. Nat. Hist. Soc. 30, 1925, pl. 1, f. 1; id. in Journ. Ind. Bot. Soc. 7, 1928, f. 12; AGHARKAR & KUNDU in Journ. Dep. Sci., N. S. 1, 1937, pl. 9, f. 2; the pres. paper, figs. 15*a*—*d*.

Plant monoecious, greyish green, slightly incrusted, very brittle, c. 20 cm high. *Stem* rather slender, up to 600 μ in diam. *Internodes* as long as or somewhat longer than the branchlets. *Cortex* triplostichous, primary cortical-cells equally developed as the secondary ones. *Spine-cells* rather frequent, short, solitary, especially developed on young branchlets, up to 60 μ long. *Stipulodes* in a double whorl, twice as numerous as the branchlets, the cells of the lower whorl usually very short, c. 225 μ long, c. 100 μ wide, those of the upper row 600 μ long, c. 60 μ wide, acute, somewhat incurved. *Branchlets* 9—12 in a whorl, consisting of 5—8 articulations, the lowest articulation shorter than the stipulodes, colourless and hidden behind them, consequently triple-corticate. *Bract-cells* 6—8, posterior pair reduced to papillae or wanting, on fertile nodes c. 500 μ long, c. 45 μ wide; on sterile nodes 225 μ long, 75 μ wide. Terminal branchlet-articulation very

short, penultimate one long. *Bracteoles* similar to but longer than the anterior bract-cells, somewhat shorter than or as long as the oogonia. ♂ and ♀ *gametangia* at the three lowest nodes, solitary, at the same nodes. *Antheridia* 310—390 μ in diam., earlier ripe than oogonia. *Oogonia* 710—795 μ long (incl. coronula), 600—650 μ wide; *spiral-cells* showing 13—15 convolutions; *coronula* 115 μ high, c. 250 μ wide at base, individual cells rather short and blunt, connivent, or a little converging; *oospores* black, 560—760 μ long, 500—595 μ wide, with 12—13 ridges.

INDIA: Assam, without date and collector's name, herb. HOOKER 1867 (K).

INDO-CHINA: Tonkin, central part, Kiên Khê, in the river Dông, 19 X 1883, BON 2306 (P).

JAVA: Bantam, Tjipining, V 1934, no collector's name (Bz).

BALI: S. Bali, Danoe Batoer, caldera lake of the G. Batoer, depth 1.5 m, 1031 m alt., 21 VI 1929, German Limnol. Sunda Exp. BB3c (Bu-Mus).

NEW GUINEA: Territory of N. G., K. Wilhelmsland, Kélana, 28 VI 1888, KÖRNBACH s.n. (B, K, S).

Vernacular name: Rong = Fucus (Tonkin).

Remarks. *Chara brachypus* very much resembles *C. inermis* from which it is at once distinguished by the presence of spine-cells, the rudimentary stipulodes and the larger gametangia. The triplostichous *C. Handae* has ecorticate branchlets whereas in *C. brachypus* they are double corticate. *C. infirma* is dioecious. The species still more resembles *C. zeylanica*, from which it is distinguishable by examination of the lowest branchlet-articulation, which in *C. brachybus* is corticated.

These cortical-cells of the lowest articulation are often overlooked on account of their transparency, as is recently shown by FILARSZKY (1934, p. 724), who writes: "ein äusserst kurzes unberindetes Basalglied"; and the same is found in BRAUN's notes to his type description (1849, p. 298), where he writes: "... among which the shortness of the first joint of the leaves, which is uncovered and hidden beneath the stipulae...". However, this is most probably a misprint and has to read "uncoloured", as on the following page BRAUN says, on quoting the differences between *C. brachypus* and other species: "But in *C. polyphylla* the first joint of the leaf is not only uncoloured, but also uncovered and therefore not striated". G. O. ALLEN (1928, p. 65) supposes that the pale colour of this lowest articulation is due to its not taking up lime, as is also the case in the coronula-cells, reason why the latter cells are never found fossilized. I do not know the plant in a living state, nor whether chlorophyll is extant in the cells mentioned.

In the synonyms I put an interrogation-mark before the names of *C. setigera* and *C. setosa* because I have not seen any specimens of these. It is still doubtful whether the oldest name is *brachypus* or *setosa* under which the species was first published by WILLDENOW, and under which it was recognized by the authors up to 1849. However, according to BRAUN (1849, p. 299) the authors of *C. setosa* did not know exactly their own species, and confounded it with *C. zeylanica* as can be stated on comparing WILLDENOW's herbarium. Without absolute certainty it seems better to emphasize this question rather than changing an once accepted name.

BRAUN has distinguished two varieties, viz. *gracilescens* (1849, p. 298) and *Ehrenbergiana* (1867, p. 230; 1868, p. 867) occurring near Madras and in Egypt respectively. Var. *gracilescens* is probably a slender form with less than 8—9 branchlets, inconspicuous spine-cells, whereas the uncoloured lowest articulation is longer than the stipulodes. Var. *Ehrenbergiana* is somewhat aberrant as the branchlets in the lower whorls and in some of the upper ones are entirely ecorticate. Most probably it is a monstrosity.

Ecology. *Chara brachypus* is a moderately stout plant with a greyish green colour due to the lime incrustation. It occurs in shallow drains and slightly flooded fields. In Bali it was collected at a depth of 1.5 m in a caldera lake with a total depth of 90 m. From this locality some other data may be taken from the label, viz. surface temperature 22.7° C., alkalinity $5.80 . 10^{-4}$, Cl-content 209 mg per l, pH 8.5.

It has most probably no preference for lowland or mountainous areas. The bottom must be solid, for G. O. ALLEN (1928, p. 65) remarks that he never found it growing in soft mud.

In India the seasonal distribution ranges from August to November according to PAL (1932, p. 51), whereas ALLEN (1928, p. 66) records ripe oospores in Saharanpur from July to December; in Malaysia they are found in May and June.

C. brachypus occurs very frequently together with other *Charophyta*, i.e. *C. burmanica*, *C. Grovesii*, *C. Handae* and *C. fibrosa* ssp. *flaccida*. Recorded as epiphytes are species of *Oedogonium*.

Distribution. Between 31° N. and 15° S.; ASIA, India: Assam; Indo-China; Java; Bali; New Guinea. Moreover in lit.: India: W. Himalaya, MUKERJI (1931, p. 206); India Deserta, Malabaria, GROVES (1924, p. 375), DIXIT (1931, p. 206), Coromandelia, BRAUN (1849, p. 298), GROVES (1924, p. 375), Gangetic Plain, BRAUN

& NORDSTEDT (1882, p. 185), GROVES (1924, p. 375), GROVES & ALLEN (1927, p. 339), ALLEN (1928, p. 65), ? AGHARKAR & KUNDU (1937, p. 18), Burma, PAL (1932, p. 87); Malaysia: Timor, NORDSTEDT (1889), p. 8), DE WILDEMAN (1899, p. 96), ? Philippine Islands, GROVES (1912, p. 70) — AFRICA, N. Afr.: Egypt, Egyptian Sudan, BRAUN (1868, p. 868); KUETZING (1849, p. 522); S. Afr.: Angola, BRAUN (1868, p. 868); Madagascar, GROVES (1927, p. 135), ZANEVELD (1939, p. 382) — AUSTRALIA, N. Austr.: ex GROVES (1924, p. 375).

3. GYMNOBASALIA ZANEV., nov. nom. — *Gymnopodes* A. BRAUN in HOOKER's Journ. Bot. 1, 1849, p. 203; id., id., p. 299; id. in Monatsber. Kön. Akad. Wiss. Berlin f. 1867, p. 800, 1868; BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 23; T. F. ALLEN, Charac. America 1, 1888, p. 62; NORDSTEDT in Proc. Roy. Soc. Vict. 31, N. S., 1918, p. 6; J. GROVES in Journ. Linn. Soc., Bot., 46, 1924, p. 375; PRINTZ in ENGLER & PRANTL, Nat. Pfl. fam. 3, ed. 2, 1927, p. 429; GROVES & ALLEN in Proc. Roy. Soc. Queensl. 46, 1935, p. 59; ZANEVELD in Blumea 3, 1939, p. 381.

Lowest articulation of the branchlets destitute of cortical-cells.

Remarks. The alteration of the name of this series was necessary as BRAUN's name duplicates one earlier given to a series of the *Haplostephanae.*

25. Chara zeylanica WILLDENOW in Mém. Ac. Roy. Berlin p. 1803, p. 86, 1805; id. in Samml. d. Abh. Kön. Akad. Wiss. Berlin f. 1803, p. 59, 1806 — *Chara armata*; *C. armata* var. *diaphana*; *C. ceylanica*; *C. ceylonica*; *C. foliolosa*; *C. gymnopus*; *C. gymnopus* var. *ceylonica,* var. *armata,* var. *armata* f. *paragymnophylla*; *C. haitensis*; *C. polyphylla*; *C. polyphylla* var. *ceylonica,* var. *Meyenii,* var. *Meyenii* f. *paragymnophylla*; *C. variabilis*; *C. zeylonica*; *Conferva littoralis*; cf. formae.

Plant monoecious, greyish to brownish green, frequently heavy impregnated with lime, up to 25 cm high (sometimes more). *Stem* stout, 600—800 μ in diam. *Internodes* 0.5—3 times as long as the branchlets. *Cortex* triplostichous, primary cortical cell-series equally developed as the secondary. *Spine-cells* numerous, varying in length from 60 to 700 μ, acute, c. 90 μ wide, especially developed just above and below a stem-node. *Stipulodes* in a double whorl, twice as numerous as the branchlets, acute, exceeding the lowest branchlet-articulation in length, c. 900 μ long, 90—105 μ wide at base. *Branchlets* 11—14 in a whorl, composed of 8—13 articulations, the short lowest and usually 1—3 ultimate articulations ecorticate (cf. f. *armata* and f. *diaphana),* all

other ones triply corticated. *Bract-cells* 6—8 (usually 6), anterior pair 1—3 times the length of the oogonium, posterior ones usually half as long as the oogonium; apices of the bract-cells usually incrusted, therefore they seem to be blunt. *Bracteoles* similar to the anterior bract-cells, but longer. ♂ and ♀ *gametangia* most frequently only produced at the nodes of the corticated articulations, solitary at the same nodes. *Antheridia* 400—500 μ in diam., enveloped in four shields. *Oogonia* 760—950 μ (incl. coronula), 440—560 μ wide; *spiral-cells* showing 12—15 convolutions; *coronula* 95—134 μ high, 170—230 μ wide at base, individual cells ovate, spreading at the apex; *oospores* black, 650—710 μ long, 320—350 μ wide, with 10—12 small ridges.

Remarks. The tropical species *par excellence*, *Chara zeylanica*, is one of the most variable species as is already pointed out by several authors. Specimens which vary but slightly from the type are either described as forms (Braun & Nordstedt, 1882, pp. 189—199) or they are considered as species (Robinson, 1906, pp. 282—295). When more material was collected, more transitional stages became evident. Therefore, H. & J. Groves (1911, p. 41) did not maintain the 14 species of Robinson, but accepted for the West-Indies 9 forms, for which they state that nearly all the specimens appeared to be more or less intermediate and rarely agree exactly with any of the named forms.

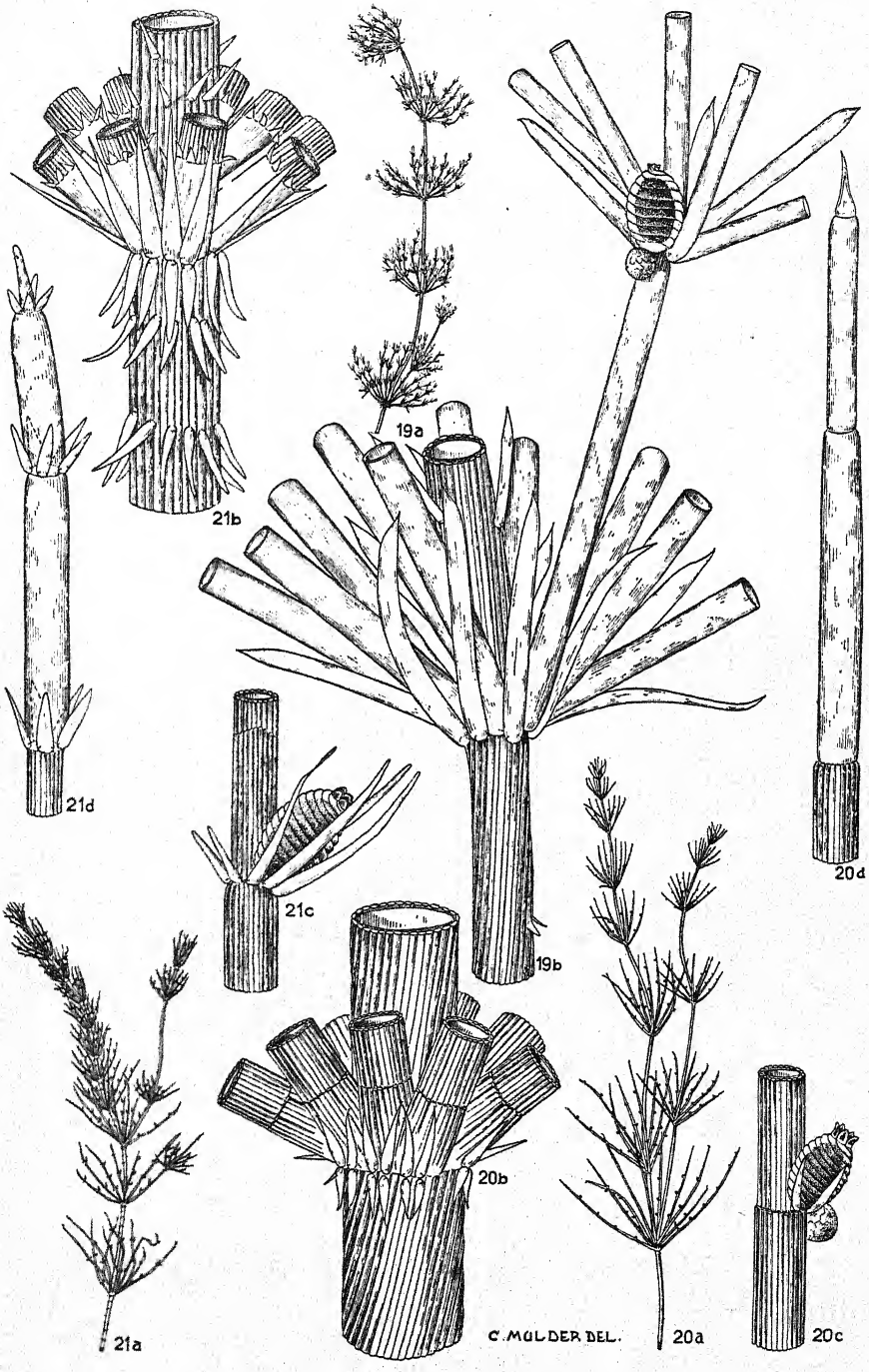
This extreme variability of this species has lately led Filarszky (1934, p. 721) to the establishment of a new species, *C. variabilis*. This name at the same time expresses very well the extraordinary variability, however, after studying his specimens it appears that not one single feature asserts, on account of which the plants could be considered a separate species.

The Malaysian exsiccatae are macroscopically readily separable into two groups, the one with a long slender habit, the other with a more compact appearence. The plants of the former group have the branchlets, spine-cells and bract-cells rather short, i. e. not visible to the naked eye (forma *typica*), whereas the plants of the other group have long branchlets, spine-cells and bract-cells, which are macroscopically visible (f. *armata* and *diaphana*).

Chara zeylanica is the only member of the *Triplostichae* which

Fig. 19, *Chara fibrosa* ssp. *Benthamii*; *a.* habit, nat. size; *b.* stem-node with part of fertile branchlet, × c. 15 — Fig. 20, *Chara inermis*, n. sp.; *a.* habit, nat. size; *b.* stem-node, × c. 26; *c.* fertile branchlet-node, × c. 30; *d.* apex of branchlet, × c. 34 — Fig. 21, *Chara zeylanica* f. *typica*, n. f.; *a.* habit, nat. size; *b.* stem-node, × c. 16; *c.* fertile branchlet-node, × c. 18; *d.* apex of branchlet, × c. 21.

Pl. 6



has the lowest branchlet-articulation ecorticate and by this feature it cannot be confused with any other *Chara*, except perhaps *C. javanica*, described by BRAUN (1849, p. 300), whereas WALLMAN (1856, p. 57) has taken over this description. However, the description of the last-named species is insufficient for an exact determination and the specimen has probably not been preserved. Afterwards it has been mentioned by WALLMAN (1856, p. 57), however, without a sufficient description. I think it probably a form of *C. zeylanica*.

Another characteristic, as far as we know specific for *C. zeylanica*, is that the antheridium is enveloped in four shield-cells instead of eight as is the case in all other *Charophyta* (cf. GROVES, 1931, p. 97).

I have followed GROVES (1898, p. 323) in using WILLDENOW's name *zeylanica* for this species. However, there is some doubt whether this name or that of *C. foliolosa* is valid. Both names are published by WILLDENOW at the same time (1805, p. 86), but that of *C. foliosa* is mentioned first. Neither BRAUN's names *C. gymnopus* (1868, p. 70; published as a *nomen nudum* in 1847, p. 23), nor his *C. polyphylla* (1835, p. 70) especially used by himself and by the authors of the 19th century, is validly published as is clear from his own explanation in 1858 (pp. 361—362). BRAUN regarded *C. foliolosa* as a variety of *C. polyphylla* (1849, p. 300), whereas GROVES (1911, p. 40) cited it as a synonym of *C. zeylanica*. As I did not see the type specimens I cannot give a decision just now.

E c o l o g y. *Chara zeylanica* is a robust species occurring in almost all types of fresh water in the tropics and subtropics. It is therefore found in lakes, ponds, moats, jhils, rice-fields, pools, etc., though the water may also be brackish as is shown by the Java specimens collected by SUNIER, whereas DIXIT (1931, p. 206) found it in saline waters of Salsette, containing c. 2.5 % NaCl and SENIOR-WHITE (1926) in a drain with c. 3.3 % NaCl.

It is, as a rule, heavily incrusted with lime, which is sometimes annular in character. The species is not found at great altitudes, but according to its cosmopolitan character it may be found in the lowlands as well as in the mountainous regions.

Concerning the particulars of the environment there is only one note, viz. on a label of the Sumatra plants from lake Singkarak. This lake measures c. 108 km², 21 km long, 7 km wide, 269 m deep, 360 m alt., temperature of the surface 27—28° C., pH 8.7, alkalinity $1.6 . 10^{-4}$.

As to the seasonal distribution I may remark that it is found

in India from September to December (PAL, 1932, p. 51; ALLEN, 1925, pl. 5; 1928, p. 66). According to ALLEN (1925, p. 599) it prefers in Gonda the rainy season, as it was found in great masses at the end of the rains but no signs of it later. In Malaysia it is found all the year round, December and January excepted.

As epiphytes are quoted *Rivularia dura* and *Gleotricha pisum* (DIXIT, 1931, p. 206).

Distribution.[1]) Between 50° N. and 23° S.; ASIA, India; Siam; Malay Peninsula; Malaysia; Andaman Islands — AUSTRALIA; New Caledonia; Hawaiian Islands; cf. formae. Moreover in lit.: AMERICA, N. Am.: United States, T. F. ALLEN (1872, p. 10; 1894, p. 164), BRAUN & NORDSTEDT (1882, pp. 190, 191, 195, 197), ROBINSON (1906, pp. 286, 287, 290, 295, 296); Texas, BRAUN (1858, p. 363), BRAUN & NORDSTEDT (1882, pp. 190, 194—196), ROBINSON (1906, p. 295); C. Am.: Mexico, BRAUN (1858, p. 363), BRAUN & NORDSTEDT (1882, pp. 194, 196, 197), T. F. ALLEN (1894, p. 164), ROBINSON (1906, p. 287, 289); Guatemala, BRAUN & NORDSTEDT (1882, p. 195), NORDSTEDT (1888, pp. 192, 193), ROBINSON (1906, p. 287); Nicaragua, BRAUN & NORDSTEDT (1882, p. 193); Bermuda Islands, NORDSTEDT (1889, p. 40), GROVES (1911, p. 43), BRITTON (1918, p. 504); Bahama Islands, T. F. ALLEN (1894, p. 167), GROVES (1911, p. 43); Greater Antilles, BRAUN & NORDSTEDT (1882, p. 195), NORDSTEDT (1888, pp. 192, 194), T. F. ALLEN (1894, p. 163), ROBINSON (1906, pp. 283, 292), GROVES (1911, p. 43); Lesser Antilles, BRAUN & NORDSTEDT (1882, pp. 194, 195, 198), ROBINSON (1906, p. 285), GROVES (1898, p. 324; 1911, pp. 43, 44); S. Am.: Venezuela, BRAUN (1858, p. 360), BRAUN & NORDSTEDT (1882, pp. 194—196), ROBINSON (1906, p. 293) — AFRICA, N. Afr.: Egypt, BRAUN (1868, p. 870), BRAUN & NORDSTEDT (1882, pp. 189, 191); Somaliland, BRAUN & NORDSTEDT (1882, p. 196); S. Afr.: Angola, BRAUN (1868, p. 871); Mauritius, Réunion, BRAUN (1868, p. 872), Madagascar, BRAUN (1868, p. 872), GROVES (1927, p. 136), ZANEVELD (1939, p. 199).

f. 1. **typica** ZANEV., nov. form. — *Chara zeylanica* WILLDENOW in Mém. Ac. Roy. Berlin p. 1803, p. 86, 1805; id. in Samml. d. Abh. Kön. Ak. Wiss. Berlin f. 1803, p. 59, 1806; id., Spec. Plant. 4, 1805, p. 184; PERSOON, Syn. Plant. 2, 1807, p. 530; AGARDH, Syst. Alg., 1824, p. 128; BRUZELIUS & FUERNROHR in Flora 9, 1826, p. 486; KUETZING, Tab. Phyc. 7, 1857, p. 302; H. & J. GROVES in Journ. Linn. Soc., Bot., 33, 1897, p. 323; id. in URBAN, Flor. Ind. Occ. 7, 1911, p. 40; id. in Philipp. Journ. Sci. 7,

[1]) For extensive literature quotations, cf. the formae.

1912, p. 70; MERRILL, Spec. Blancoanae, 1918, p. 39; J. GROVES in Journ. Linn. Soc., Bot., 46, 1922, p. 102; id. in Journ. Linn. Soc., Bot., 46, 1924, pp. 363, 375; G. O. ALLEN in Journ. Bombay Nat. Hist. Soc. 30, 1925, p. 597; GROVES & ALLEN in Journ. Bot. 65, 1927, p. 339; G. O. ALLEN in Journ. Ind. Bot. Soc. 7, 1928, p. 65; J. GROVES in Journ. Linn. Soc., Bot., 48, 1928, p. 136; PAL in Journ. Burma Res. Soc. 18, 3, 1929, p. 113 (*nom. tant.*); DIXIT in Journ. Ind. Bot. Soc. 10, 1931, p. 206; PAL in Journ. Linn. Soc., Bot., 49, 1932, pp. 65, 88; MUKERJI in Proc. 21st Ind. Sci. Congr., Bombay, 1934, p. 295; DIXIT in Journ. Ind. Bot. Soc. 14, 1935, p. 262; GROVES & ALLEN in Proc. Roy. Soc. Queensl. 46, 1935, pp. 42, 59; AGHARKAR & KUNDU in Journ. Dep. Sci., N. S. 1, 1937, pp. 11, 18; ZANEVELD in Blumea 3, 1939, pp. 381—382 — *Chara foliolosa* MÜHLENB. ex WILLDENOW in Mém. Ac. Roy. Berlin p. 1803, p. 86, 1805; id. in Samml. d. Abh. Kön. Ak. Wiss. Berlin f. 1803, p. 58, 1806; id., Spec. Plant. 4, 1805, p. 184 — *Chara haitensis* TURPIN in Dict. Sci. Nat., 1826, Veg. Acot. p. 101; FILARSZKY in Arch. Hydrobiol. 1934, Suppl. Bd. 12, Trop. Binnengew. Bd. 4, p. 725 — *Chara verticillata* ROXBURGH, Fl. Ind. 3, 1832, p. 563; HATE in Journ. Bomb. Nat. Hist. Soc. 19, 1909, p. 762 (as *verticulata*) — *Chara polyphylla* A. BRAUN in Regensb. Bot. Zeit. 1, 1835, p. 70 *p.p.*; id. in HOOKER's Journ. Bot. 1, 1849, p. 299 — *Chara polyphylla* var. *ceylonica* A. BRAUN in HOOKER's Journ. Bot. 1, 1849, p. 300 — *Chara zeylonica* WILLD., KUETZING, Spec. Alg., 1849, p. 522 — *Chara gymnopus* A. BRAUN in N. Denkschr. Schw. Ges. Naturw. 10, 1849, p. 23 (*nom. tant.*); id. in Monatsber. Kön. Akad. Wiss. Berlin f. 1867, p. 870, 1868, *pro parte* — *Chara ceylonica* (KLEIN) WILLD., WALLMAN in Act. Soc. Linn. Bordeaux 21, 1856, p. 56 — *Chara ceylanica* WILLD., BRAUN in MARTENS' Die Preuss. Exp. n. O.-Asien, Bot. Th., 1866, p. 143 — *Chara gymnopus* A. BR. var. *ceylonica* A. BRAUN in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 197; T. F. ALLEN, Charac. Americ. 1, 1888, p. 63 (*nom. tant.*); NORDSTEDT in Lunds Univers. Års-skr. 25, 1889, p. 40; NORDSTEDT in Forschungsreise S. M. S. "Gazelle", 1889, p. 8; DE WILDEMAN, Prodr. Flor. Algol. Ind. Néerl., 1897, p. 30; id., Suppl. et Tabl. Stat., 1899, p. 98; id., Alg. Fl. Buitenz., 1900, p. 374; BAILEY, Compreh. Catal. Queensl. Plants, 1909, p. 682; NORDSTEDT in Proc. Roy. Soc. Vict., N. S. 31, 1918, p. 6 (*nom. tant.*).

Illustrations. WILLDENOW in Mém. Ac. Roy. Berlin p. 1803, pl. 2, f. 1, 1805; id. in Samml. d. Abh. Kön. Ak. Wiss. Berlin f. 1803, pl. 2, f. 1, 1806; KUETZING, Tab. Phyc. 7, 1857, pl. 76, f. 1; G. O. ALLEN in Journ. Ind. Bot. Soc. 7, 1928, f. 13; AGHARKAR & KUNDU in

Journ. Dep. Sci., N. S. 1, 1937, pl. 9, f. 3; the pres. paper, figs. 21*a—d.*

Planta grandis, tenuis, elongata. *Internodia* quam ramuli duplex longiora. *Spinulae* paucae, ¼ quam diameter caulis longiores. *Verticillorum ramuli* 11—12, erecti, c. 1.5—4 cm longi, articulationes 7—14, quarum 6—10 corticatae, 1—4 ecorticatae. Nodi inferiores steriles. *Oosporae* c. 700 μ longae.

Plant large but slender. *Internodes* 2 times as long (and sometimes more) as the branchlets. *Spine-cells* short, acute, cone-like, rather few, ¼ as long as the diam. of the stem, not visible with the naked eye. *Branchlets* straight, 11—12 in a whorl, 1.5—4 cm long, with 6—10 corticate articulations and 1—4 ecorticate ones, the ecorticate lowest articulation excepted, which is thrice as long as wide. First branchlet-node sterile. *Oospores* usually 700 μ long.

SIAM: Pak Raw, inside channel between two parts of Talé Sap (water 4—6 m, brackish), 25 I 1916, ANNANDALE 15 (Si), together with *Chara corallina* and *C. hydropitys.*

SUMATRA: Tapanoeli, Perapat, in a quiet bight of Lake Toba, rooting at a depth of 2 m, alt. c. 906 m, 27 V 1923, LÖRZING 10115b (Bz), badly preserved sterile fragments, therefore not to be identified with certainty; ibid., Lake Toba, at the border of Samosir Isl., from 12 m depth, 12 IV 1929, German Limn. Sunda Exp. TH1a (Bu-Mus).

JAVA: Priangan, Sitoe Bagendit, without date, and collector's name (L), two robust specimens; ibid., near Garoet, in a lake, 11 II 1894, VON SCHIFFNER s.n., Iter indicum 1893—'94 (L), 4 robust sterile specimens, therefore identification not certain.

BALI: S. Bali, near Bangli, in the lake Danoe Batoer, 973 m alt., 8 IX 1857, ZOLLINGER 3386 ? (L), det. A. BRAUN as "*N. Zollingeri* BR.".

KAI ISLANDS: Ohoitiel near Toeal, floating in the lake, 2 V 1922, Danish Exp. to the Kai Islands 1922, JENSEN 297 (Bz, L), sterile specimens.

Remarks. The plants belonging to this form are macroscopically characterized by the large, but slender habit with long branchlets and internodes. They do not possess macroscopically visible spine-cells and are thereby distinguishable from f. *armata.* As the discrimination of these two forms is not always taken into account, the distribution must of necessity be incomplete.

Distribution. Between 35° N. and 20° S.; ASIA, Siam; Malaysia: Sumatra; Java; Bali; Kai Islands. Moreover in lit.: India: W. Himalaya, MUKERJI (1934, p. 295); Malabaria, WILLDENOW (1805, p. 84), DIXIT (1931, p. 206; 1935, p. 262); Coromandelia, BRAUN (1849, p. 300), BRAUN & NORDSTEDT (1882, p. 197); Ceylon, WILLDENOW (1805, p. 184), BRAUN & NORDSTEDT (1882, p. 197), GROVES (1922, p. 102); Gangetic Plain, BRAUN (1849, p. 300), ALLEN (1925, p. 597; 1928, p. 65), GROVES & ALLEN (1927, p. 339); Assam; Andaman Islands;

Malaysia: Malay Peninsula, GROVES (1924, p. 375); Bali, BRAUN & NORDSTEDT (1882, p. 197), DE WILDEMAN (1897, p. 30); Cocos Islands, GROVES (1924, p. 375) — AUSTRALIA, N.W. Austr.: NORDSTEDT (1889, p. 8); N. Territory, Victoria River, BRAUN & NORDSTEDT (1882, p. 197); Queensland, Mitchell River, Carpentaria, NORDSTEDT (1889, p. 59), BAILEY (1909, p. 682), GROVES & ALLEN (1935, p. 59).

f. 2. **armata** (MEYEN) ZANEV., nov. comb. — *Chara armata* MEYEN, Reise um die Erde 2, 1835, p. 131; KUETZING, Tab. Phyc. 7, 1857, p. 30 — *Conferva littoralis* BLANCO, Flor. Filip., 1837, p. 843; id., ed. 2, 1845, p. 582; id., ed. 3, 3, 1879, p. 263 — *Chara polyphylla* A. BR. var. *Meyenii* A. BRAUN in HOOKER's Journ. Bot. 1, 1849, p. 300; WALLMAN in Act. Soc. Linn. Bordeaux 21, 1856, p. 57 — *Chara gymnopus* A. BR. var. *armata* (MEYEN) NORDSTEDT in Physiogr. Sällskap. Minesskr., 1878, p. 23; BRAUN & NORDSTEDT in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 191; T. F. ALLEN, Charac. America 1, 1888, p. 63 (*nom. tant.*); LAMMERMANN in ENGLER's Bot. Jahrb. 34, 1905, p. 635; MACCAUGHEY, Alg. Hawaiian Arch. 2, Bot. Gazette 65, 1918, p. 136 — *Chara variabilis* FILARSZKY in Arch. Hydrobiol. 1934, Suppl. Bd. 12, Trop. Binnengew. Bd. 4, p. 721; id. in Math. u. Naturw. Anz. Ung. Akad. Wiss. 52, 1935, p. 468 (*nom. tant.*).

Illustrations. KUETZING, Tab. Phyc. 7, 1857, pl. 75, f. 1; FILARSZKY in Arch. Hydrobiol. 1934, Suppl. Bd. 12, Trop. Binnengew. Bd. 4, figs. 75—80.

Plants more compact than f. *typica*. *Internodes* 1.5 times the length of the branchlets. *Spine-cells* long, acute, very frequent, up to as long as the diam. of the stem. *Branchlets* 10—12 in a whorl, rigid, with 5—10 corticated articulations and 1—4 ecorticate ones; the ecorticate lowest articulation is 3—5 times as long as the diam. The lowest branchlet-node is sterile. *Oospores* usually 700 μ long.

INDIA: Coromandelia, Pondichery, no date, PERROTTET 610, herb. HASSKARL in (L).

SUMATRA: Atjeh, Takengon, in Laoet Tawar, 1180 m alt., 30 VIII 1934, VAN STEENIS 6063 (Bz), sterile; Tapanoeli, Batakdistr., Lake Toba, 16 VII 1904, VAN DAALEN 539c (Bz, L); ibid., Lake Toba, Porsea Basin, south border from 4 m depth, 8 IV 1929, German Limnol. Sunda Exp. TP1c (Bu-Mus), *type* of *C. variabilis* FILARSZKY; West Coast, Padangse Bovenlanden, Lake Singkarak, 6 III 1929, 2 specimens floating on the surface near the W. border, 4 specimens from a depth of 50—70 cm, 2 specimens from the W. border near Panjingahan from 1—1.5 m depth, 16 III 1929, German Limnol. Sunda Exped. Sk4e and Sk4 (Bu-Mus), cotype of *C. variabilis* FILARSZKY.

JAVA: Batavia, Tjilintjing, in a marine fishpond, 26 V 1922, SUNIER s.n. (Bz, L).

PHILIPPINE ISLANDS: Luzon, Manila, in pools, XI 1914, MERRILL, Species Blancoanae 180 (Bz, K, L).

NEW CALEDONIA: without exact locality, 1868—1870, BALANSA 1551 (P).

Remarks. Forma *armata* is at once recognizable by the short, straight branchlets with the long bract-cells and by the long spine-cells, already visible with the naked eye. KUETZING's figure (1857, pl. 75) of the habit is very striking. Plants with more than four naked articulations are to be inserted in the f. *diaphana*.

The reasons why I have not accepted FILARSZKY's new species *C. variabilis* are pointed out on p. 204.

Distribution. Between 13° N. and 23° S.; ASIA, India; Malaysia: Sumatra, Java, Philippine Islands — AUSTRALIA, New Caledonia, MERRILL (1918, pp. 39, 40), GROVES (1912, p. 70).

f. 3. **diaphana** (MEYEN) ZANEV., nov. comb. — *Chara armata* MEYEN var. *diaphana* MEYEN, Reise um die Erde 2, 1835, p. 131; KUETZING, Tab. phyc. 7, 1857, p. 30 — *Chara polyphylla* A. BR. var. *Meyenii* A. BR. f. *paragymnophylla* A. BR. in HOOKER's Journ. Bot. 1, 1849, p. 300 — *Chara gymnopus* A. BR. var. *armata* (MEYEN) NORDST. f. *paragymnophylla* A. BRAUN in Abh. Kön. Akad. Wiss. Berlin 1882, p. 191.

Illustrations. KUETZING, Tab. Phyc. 7, 1857, pl. 75, f. 2.

Differs from f. *armata* only by having more than four ecorticate branchlet-articulations. The same branchlet-whorl contains sometimes also entirely ecorticate branchlets. This particular is very well shown in KUETZING's figure. Another characteristic is the fertility of the lowest branchlet-node.

BALI: Soember Klampok, in desiccating pools surrounded by *Excoecaria*, 21 VII 1934, DE VOOGD 2175 (Bz).

HAWAIIAN (SANDWICHS) ISLANDS: without further particulars [but most probably collected in Oahu by MEYEN, V 1831, cf. *C. Braunii* var. *oahuensis*], (L), fragment of the *type*; ibid., IV 1883, BAILEY s.n. [T. F. ALLEN, Charac. Americ. Exsicc. 40], (L), badly preserved specimens; Oahu, in lower Panuoa, 4 VI 1895, HELLER, Plants of the Hawaiian islands 2386 (L).

Remarks. The above cited plants differ but slightly from the f. *armata*, but the branchlets have more ecorticate articulations and the lowest node is fertile. These characteristics suffice to consider the plants representing a form but not a variety as MEYEN did.

The plants from Bali were treated with sublimate, they have therefore a somewhat unusual appearance; the plants are entirely subdiaphanous.

Distribution. Between 22° N. and 7° S.; ASIA, Malaysia: Bali — Hawaiian Islands.

Doubtful and little-known species and varieties.

Nitella fascicularis FILARSZKY et G. O. ALLEN in Math. Naturw. Anz. Ung. Akad. Wiss., Budapest 55, 1937, p. 478, figs. 6—12. Recorded from Kuala Lumpur, Malay Peninsula. Probably belonging to the dioecious *Homoeoclemae-Bicellulatae*; cf. p. 9.

Nitella tenuissima (DESV.) KUETZ. var. **byssoides** A. BRAUN in Abh. Kön. Akad. Wiss. Berlin, 1882, p. 64. First described by BRAUN (1849, p. 294) as *Nitella byssoides* from the Coast of Coromandel; cf. p. 99.

Chara foetida and **Chara spinalis** ex herbarium HAMILTON. Collected in Bangsi, Malay Peninsula; quoted without further comment in WALLICH's "Catalogue" (1928, p. 181) under Nos. 5190 and 5188 respectively and again by BRAUN (1849, p. 301).

Chara fulgens FILARSZKY in Arch. f. Hydrobiol. 1934, Suppl. Bd. 12, Trop. Binnengew. Bd. 4, p. 720. Recorded from Bali; cf. p. 136.

Chara hispida ex herbarium Madras. Mentioned without locality or other particulars by WALLICH in his "Catalogue" under No. 5189 and by BRAUN (*l. c.*, p. 301).

Chara javanica A. BRAUN in HOOKER's Journ. Bot. 1, 1849, p. 300; WALLMAN in Bull. Soc. Linn. Bordeaux 21, 1856, p. 57; T. F. ALLEN in Bull. Torrey Bot. Cl. 7, 1880, p. 107 (*nom. tant.*). Recorded from Java; cf. p. 5.

Chara polyclados DON. Cited by BRAUN (1849, p. 301) only as a *nomen tantum* with the remark "ubinam descripta?" and supposed to occur in the area dealt with in the present paper.

Chara soluta GRIFFITH, Not. Pl. Asiat. 2, 1849, p. 280. Probably collected in Hurdwar (= Haredwara, India Deserta). The species is insufficiently described and has never been mentioned again, whereas the type specimen seems to have disappeared.

Index to collectors' numbers,

with reference to the pages by means of the numbers in parentheses.
s.n.: unnumbered specimens.

MacGregor: 27630 (60) — E. von Martens: s.n. (78, 133); 4 (94) — Merrill: 180 (211) — Meyen (v. also coll. unknown): s.n. (147) — Motley 9 (164); 218 (164); 329 (162); 728 (104) — F. von Mueller: s.n. (125[5 ×], 127, 128); 5 (127[2 ×]); 24 (162).

Naumann: s.n. (129); 6 (103); 337 (103); 338 (103); 364 (60); 365 (61); 366 (61); 367 (60) — Nur: s.n. (157).

Perrottet: 610 (210) — Pestava: s.n. (75, 157).

Ramos: 26748 (172); 27248 (157); 27465 (93) — Ridley: s.n. (103, 157, 162, 164); 6915 (157); 7142 (103); 7144 (104); 8089 (162); 9137 (61); 10827 (75); 12567 (157); 26748 (172) — Robinson: 2404 (61) — Roux: s.n. (133).

de la Savinierre: 674 (85) — von Schiffner: s.n. (146, 209) — Sporleder: 1 ? (148) — van Steenis: s.n. (72); 1157 (88); 1510 (60); 4524 (149); 4799 (107); 4962a (75); 4962b (75); 5683 (78); 6063 (210) — Stockes: s.n. (60, 67) — Strachey & Winterbottom: s.n. (142, 183) — Stuart: s.n. (126); 1565? (126) — Sunier: s.n. (210).

Teysmann: s.n. (85); 11179 (164); 11930 (103) — Thomson (v. Hooker) — Tsun Yi Hsien (v. Liang Feng Yah).

Vieillard: 1984? (134) — de Voogd: 2175 (211).

Wichura: 2005 (61); 2072 (94); 2700 (78) — Weber: s.n. (129); 554 (61) — Wight: s.n. (93); 133 (164) — Wilford: 238 (157) — Wools: s.n. (125) — Winterbottom (v. Strachey).

Zippelius: s.n. (78, 103, 134) — Zollinger: 3386 (94); 3386? (209); 3440 (164).

Index to scientific names.

New names and new combinations in **boldface** type; synonyms in *italics*; accepted genera in CAPITALS; page numbers indicating the most important mention in italics; an asterisk before a page number denotes a figure.